120
140
160
180
I Arctic
II Aleutian
10 Japonic
Chinese
Philippine
Papuan
Javanese
12 Australian
9 Australian
8 Indo -
Cypraea moneta
Meleagrina
Triton
Rhynchonella
Patella

STRUCTURAL

AND

SYSTEMATIC

CONCHOLOGY:

AN INTRODUCTION TO THE STUDY OF THE

MOLLUSCA.

VOL. I.

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1882.

Each shell, each crawling insect holds a rank
Important in the plan of Him who framed
This scale of beings; holds a rank, which lost,
Would break the chain, and leave behind a gap
Which Nature's self would rue.

—STILLINGFLEET.

PREFACE.

The admirable "Manual of the Mollusca," of the late S. P. Woodward, forms the basis of the present work; and in incorporating with it the numerous important acquisitions made by conchological science during the past twenty years, care has been taken to preserve its conservative spirit, as far as practicable.

The "Genera of Recent Mollusca," published by Messrs. Henry and Arthur Adams, in 1853–1858, introduced a large number of new generic and subgeneric groups, which experience has proved to be founded on unimportant or mutable characters. This work also, under the plea of priority of date of publication, substituted the vaguely-defined groups of obscure earlier writers for the more accurately described genera of Lamarck and his successors. The "Genera" certainly inaugurated the modern progressive era of systematic conchology; but, unfortunately, its vicious antiquarianism and free multiplication of genera revealed tempting opportunities to those desirous of obtaining the cheap distinction of naming new groups, or of overthrowing the names of old ones; so that for awhile the aim of many writers appeared to be scientific reputation, rather than the advance of knowledge. During the same period appeared Woodward's "Manual of the Mollusca;" and, probably, to that work, more than to any other influence, is due the gradual reaction towards a more stable classification.

An immense amount of reliable information is contained in the single 18mo volume of 486 pages, forming the first edition of Woodward (1851–1856); still, as the work was intended to

be more rudimentary in scope than that of the Messrs. Adams, many of the less important groups were insufficiently characterized or omitted. The Supplement published by Prof. Ralph Tate with the edition of 1870, included many additional genera, but scarcely represented the progress of the science to that date. Subsequent editions present no new features or additions.

Practically, more than twenty years have thus elapsed since the publication of an English text-book upon conchology; and for an almost similar period no treatise on the subject has appeared in any other country; yet these years have unquestionably been the most active in research and discovery of any in the history of the science. Dr. Kobelt, in Germany, Dr. Paul Fischer, in Paris, and myself, appear to have nearly simultaneously conceived the idea of supplying the want thus indicated.

Of Dr. Kobelt's work, now completed, it suffices to say that its elementary character makes it an introduction to, rather than a text-book of conchology. Dr. Fischer and myself have recognized the superiority of Woodward's Manual over every similar work heretofore published; and we have not only adhered generally to its plan, but largely copied from its pages.

Dr. Fischer's "Manuel de Conchyliologie," is in every respect an excellent work, well planned and abounding in original observations; and it promises, when completed, to become a worthy successor of "Woodward." Higher commendation could not be bestowed upon it. The first number of Dr. Fischer's "Manuel" appeared before I had definitely arranged the scope of my own similar undertaking; and at first I thought of abandoning the latter, to issue in its stead a translation of Fischer, with notes. But I had contemplated a work which, conservative as to genera, should nevertheless include, in a subordinate rank, the names and diagnoses of the numerous less well-marked or critical groups of modern authors; that is, these groups were to be included in more comprehensive ones, yet not extinguished.

Besides this, it had occurred to me that no conchological text-book, except translations of elementary works, had been published in this country; and that a work in which especial prominence should be given to the description and illustration of American genera would be found very useful by our students, as well as by many conchologists in other countries who are interested in American mollusks.

These designs I have decided to carry out in the present volumes. I have also aimed at more abundant illustration than is contained in the text-books referred to. The plates of this work will embrace nearly three thousand figures, mostly of good size, and sufficiently well-done to insure the recognition of the species. This feature has considerably increased the cost of the book, but will, I believe, fully recompense the purchaser for its necessarily increased price. Besides Woodward, I have availed myself fully of the large amount of valuable original material contained in the first parts of Dr. Fischer's "Manuel." My own time has been so engrossed by the study of systematic conchology, that the structural portion of my book is peculiarly indebted to Dr. Fischer; who, although an accomplished systematist, has mainly and very successfully occupied himself with anatomical investigations.

These general acknowledgments made, I have not deemed it necessary to designate by quotation-marks in the text all the paragraphs for which I am indebted to Messrs. Woodward and Fischer; but the authorities for numerous otherwise-derived statements and quotations are carefully recorded. The whole body of notes and references collated for my "Manual of Conchology," now in course of publication, has been examined for material. The "Structural and Systematic Conchology" may be considered an introduction and companion to that work. Constant and important aid in the preparation of the fossil genera has been rendered by my able colleague, Prof. Angelo

Heilprin, in charge of the invertebrate palæontological collection of the Academy of Natural Sciences of Philadelphia.

Having made such large acknowledgments, it is proper to acknowledge further that I cannot, on this occasion, properly claim the title of author; because there is very little herein contained originating with myself. The work is mainly a compilation; yet the selection and arrangement of material have been guided by experience, and if it should fail to realize reasonable expectations the responsibility for such failure must rest with

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PRIMARY DIVISIONS OF THE ANIMAL KINGDOM.

Every known animal appears to belong to one of eight principal types of structure, each of which is designated a subkingdom.

I. *Vertebrata.* The main mass of the nervous system is dorsal, protected and separated from the alimentary canal by a number of bony partitions, arranged consecutively in a single series and known as vertebræ.* From these vertebræ proceed ventral appendages termed ribs, enclosing the cavity of the body. The animal is bilaterally symmetrical, in its highest development provided with two pairs of limbs, anterior and posterior. The sexes are distinct. Each individual is developed from a single egg. Blood red.

II. *Malacozoa.* The nautilus, the common garden-snail, and the oyster, representatives of the three principal subdivisions of the mollusca proper, are familiar examples of this subkingdom. They are soft, fleshy animals, usually constructed with reference to the support of an external, hard, more or less enveloping shell, composed of carbonate of lime. Sometimes, in the cephalous mollusks, the shell is internal: that is, situated under the dorsal skin of the animal, and in such cases it is usually more simple in form, blade-like, or even reduced to a few calcareous granules. The internal shell, called "pen" of the squids certainly acts as a support to the animal in the same manner that the vertebral column does to man, but then it is not divided into segments, nor is it pierced by a spinal cord. Some cephalous mollusks are entirely without vestige of shell, either external or internal: in others the shell is horny instead of calcareous. The nervous system in the malacozoa consists of three or four pairs of ganglia, united by cords or commissures. The alimentary canal is encircled below the mouth by some of these ganglia and

* The "back-bone" is sometimes cartilaginous, and not divided into vertebræ. In Amphioxus, the most degraded of the vertebrate type, the circulation resembles that of the worms, the heart is wanting, the blood is colorless, there are no limbs: it appears to be a connecting link with the invertebrata—as all the succeeding subkingdoms are collectively designated.

their connectives, forming the œsophageal ring, whence proceed the principal cephalic nerves. Reproduction is oviparous usually, sometimes ovoviviparous.

In the Brachiopoda, the Tunicata and the Bryozoa the nervous system is more simple. These animals have usually been considered mollusks, but the two latter are now definitely excluded from the mollusca proper, whilst the former, despite structural and physiological affinities with the others, still receives the attention of Conchologists, mainly on account of its protecting bivalve shell. They together constitute a subdivision Molluscoida.

III. *Articulata.* Crabs, spiders and insects. The outer integument of the body is horny, composed of segments, bearing articulated locomotive members. The nervous system consists of pairs of ganglia arranged in the middle line of the body.

IV. *Vermes.* The body of worms is composed of segments, sometimes bearing non-articulated appendages. The nervous system varies; in the worms proper it is as complicated and similarly arranged to that of the articulates; in other forms it is reduced to a simpler structure. The digestive canal also varies: it has two orifices in the worms proper, the anus is wanting in the Planarians, and in the Cestoïdes and Acanthocephala there is no specialized alimentary tube.

V. *Echinodermata.* Star-fishes, sea-urchins, etc., sometimes called Radiata from their radiated structure. The animal is protected by an external shell or covering, sometimes calcareous. The nervous system consists of several trunks, which unite to form a ring around the mouth. The digestive tube is distinct from the visceral cavity: there is also a closed circulatory system.

VI. *Cœlenterata.* Coral animals, Actiniæ, Hydra, etc. In these the digestive apparatus is not specialized as in the Echinoderms but communicates or is confounded with the general cavity of the body. There is no closed circulatory system, and no nervous system has been detected except in some of the medusæ, where it is quite rudimentary.

VII. *Spongifera or Porifera.* The body-cavity is lined with vibratile cilia, which aid in expelling through its orifice the digestive products and eggs; this central cavity communicates through a system of afferent canals with the exterior, their outer openings representing multiple mouths.

VIII. *Protozoa.* Microscopic gelatinous animalcules, apparently without distinctive organs.

The above classification is modified from a well-known one of Prof. Huxley (though not his latest effort in this direction), and in the first subkingdoms agrees with the more ancient system of Cuvier. It is principally the Radiata of the distinguished

French naturalist that has been dismembered into distinct groups in consequence of our rapidly increasing knowledge of the diverse structure of these simpler forms of life. A comparison of the views of the most recent authorities, however, shows considerable divergence in their estimates of the systematic importance of structural peculiarities. Ray Lankester, for instance, admits no less than ten primary groups or subkingdoms below the mollusca. It matters little to the conchological student, however, whether some of the vermes be considered independent subkingdoms or not. Classification is necessarily based upon half-truths, because the values of structural differences are not demonstrably equivalent throughout, and because lines of affiliation co-exist with those of differentiation in most cases. Nature can only be artificially forced into the systematic relations of class, order, family, genus, etc. Still, these divisions have a conventional value, constantly varying according to the mental standpoint from which they are studied.

The Tunicata have been thought to form a connective link with the vertebrates through their most degraded member, Amphioxus, and Gegenbauer * makes them an independent "phylum" between Mollusca and Vertebrata; whilst E. Ray Lankester actually unites them with the latter group. The want of co-ordination of structural peculiarities in the so-called types of animals is, of course, considered important evidence for the development or derivative theory, and it has become fashionable to construct ancestral trees, bearing branches and leaves representative of the several animal types and their derivative relationships. As an example, Gegenbauer places Protozoa at the root of his tree, whence ascends a lateral, limbless trunk, terminating in Cœlenterata, whilst the main trunk rises vertically to Vermes, where it divides into branches bearing consecutively (from left to right), Mollusca, Vertebrata, Arthropoda, Brachiopoda, Echinodermata. Tunicata is a branchlet, proceeding from Vertebrata, and leaning towards Mollusca. The author of this structure speaks thus of his work: "These divisions represent in a general way separate branches of the pedigree of animals, and each of them contains higher and lower forms in various proportion. But the degree and extent to which their organization is developed is different in each of them. The divergence of organization expressed in each division is indicated by their relations to one another, and it shows us how the lower forms of the higher phyla may have started from the lower phyla."† It is sufficient, perhaps, to say here that the consanguinity indicated by the common characters of existing primary types, has not been in any

* Elements of Comparative Anatomy. † Gegenbauer, Anat., 70.

appreciable degree strengthened by geological research; the earliest fossil vertebrate, mollusk or radiate being as clearly characteristic of its type as is its modern representative. It is only in the subordinate groups that we *know* differential characters to have developed from a common ancestral form.

The Vertebrates are usually spoken of as the highest form of animal existence, the Protozoa as the lowest; but it must be borne in mind that the one is as well fitted as the other to subserve the purposes of its life, that each in its organization is equally perfect. These terms, then, indicate complex and simple rather than perfect and imperfect organization.

CLASSES OF THE MALACOZOA.

True mollusks are broadly divided into two great groups by important external characteristics:

1. *Encephala.* The animal possesses a head, and is usually protected by a spiral shell. Example, the snail.

2. *Acephala.* The animal is without a head, and is always protected by a shell consisting of two pieces applied to its sides, and connected at the back by a ligament or hinge. Example, the oyster.

To these two divisions are also familiarly applied names describing the nature of their shelly coverings; the first being known as univalves, the last as bivalves. These designations are partially incorrect and insufficient, as we shall soon see; but as the collection, preservation and study of shells is made with facility, whilst the animals or soft parts are more difficult to obtain and preserve, the former have imposed upon us a designation which may be well enough understood but is scarcely correct; it would be preferable to call our science Malacology, the study of molluscous or soft animals, yet it is almost universally known as Conchology, the Science of Shells.

I. ENCEPHALA.

Herein are included more than three-fourths of the whole number of molluscous animals including four out of the five classes into which the mollusca proper are divided. These classes take their names from and are primarily founded upon their respective locomotive organs.

Class I. *Cephalopoda.* Cuttle-fish, argonauts, and their allies, so called from the circle of feet, or more properly arm-like limbs enclosing the mouth and arising from the top of the head (Pl. xxiii).

Class II. *Pteropoda.* Animals inhabiting the high seas, swimming by means of a pair of wings, extending laterally from the back of the head. Clio, Hyalæa, etc. (Pl. xlii).

Class III. *Gastropoda* or snails. The under side of the body forms a muscular foot, suitable for gliding (Pl. xviii, f. 16).

Class IV. *Scaphopoda*. Head rudimentary. Foot vermiform, furnished with lobes. A degraded form of the encephala having relationships with Vermes, one of the most obvious of which is its shell, a hollow cylinder open at both ends, the spiral shell of the gastropod unrolled into a tube, reduced to the last degree of simplicity in form.

The shell, when present in the Encephala, is usually external and spiral, as in the helix, the whelk, nautilus, etc., but there are notable exceptions in all the classes:

In the Cephalopoda a whole order (Octopoda) is mostly without any shell, whilst another order (Decapoda) is mostly furnished with a simple shell called a pen, developed beneath the dorsal skin. Very few species of recent cephalopods have an external spiral shell, but during the earlier geological periods thousands of species of such animals existed.

In the pteropods (sometimes considered an order of Gastropoda) the shell is glassy; globular, conical, cylindrical or spiral, but is often wanting.

In the Gastropoda the shell is usually external and spiral, but sometimes tubular or even reduced to a low cone, the point of which is the beginning of its growth, the large end the mouth or aperture. Sometimes the shell is internal; occasionally internal and rudimentary, consisting of an irregular calcareous plate or several grains, and frequently altogether absent. Portions of this class are terrestrial or fluviatile, but most of its species are marine: the other classes of encephala are strictly marine animals.

The Chiton or coat-of-mail shells form an aberrant group, the shell consisting of eight distinct calcareous plates, usually overlapping, and lodged in a coriaceous skin or mantle.

In the Scaphopoda or Solenoconcha (dentalia or tooth shells) the shell is external and tubular.

All the Encephala are provided with a tongue or lingual ribbon, the superior surface of which usually bears rows of teeth used in rasping their food; many have also plates, called jaws, lodged within the mouth, and aiding in comminuting food. The cephalopods have external horny beaks, suitable for cutting or tearing. None of these organs are found in the Acephala.

II. ACEPHALA.

This term is frequently used as synonymous with the single class which it contains.

Class V. *Pelecypoda*, *Lamellibranchiata* or *Conchifera* (Pl. iii). The bivalve mollusca are familiarly represented by the oyster, clam, mussel, etc. The name Lamellibranchiata is more

usually applied to these mollusks and refers to the breathing organs, consisting of a pair of flat, membranous gills attached to the mantle. Pelecypoda is a preferable designation for the sake of uniformity with the class names in the Encephala and inasmuch as, in the cephalopods and gastropods, the next subsidiary division into *Orders* is distinguished by names indicating differences in the breathing organs. Both the breathing and locomotive organs (the latter rudimentary) restrict this class to an aqueous life: they are marine and fluviatile in distribution. The shell is generally in two pieces symmetrically applied to the sides of the animal, but there are, in one of the orders, small accessory pieces, plates or valves applied upon or on the sides of the hinge line.

Anciently shells were grouped into univalves, bivalves and multivalves, and the latter included the chitons (gastropods) the pholades (pelecypods), as well as certain lepades (crustaceans), etc.

The Molluscoida include the Brachiopoda, Tunicata and Bryozoa. The reciprocal relations of these groups scarcely justify their union as classes under this head, whilst on the other hand their individual characteristics are not sufficiently important to give them each the same systematic value as mollusca.

Class I. *Brachiopoda* are covered with a bivalve shell, the valves of which are placed dorsally and ventrally instead of being applied to the sides of the animal, as in Pelecypoda. The name is derived from two long ciliated organs developed from the sides of the mouth, which were originally termed arms—whence the term *arm-footed;* they are, however, breathing organs, and Brachionobranchia has been proposed as a more correct designation, but will scarcely obtain the preference over the shorter name so long in use.

Class II. *Tunicata.* Instead of a shell the tunicates are protected by an elastic integument, formed of cellulose, and having two orifices—mouth and anus. An inner sack with numerous openings forms the breathing organ, and the nervous system consists of a single ganglion placed near the mouth.

Class III. *Bryozoa or Polyzoa*, are microscopic animals, each protected by a calcareous or chitinous shell: they live in colonies, attached, and their aggregated shells form coralline incrustations upon the surface of molluscous shells or other marine or fluviatile objects.

Only one of the classes of Molluscoida will be included in this work. The brachiopods have so long been considered true mollusca, their shells are so similar to those of the Pelecypoda, they occur together, and have so occurred from an early geological period, so that practically they continue to be as much

the objects of the Conchologist's investigation as they were before their somewhat diverse nature was ascertained.* The Tunicata and Bryozoa, on the contrary, have never received much attention from Conchologists, the first because they could only be preserved in spirits and thus were inaccessible to most students, the last because their microscopic size and their aggregation into encrusting colonies caused them at first to be considered of much simpler organization than modern investigation has proven to be the case.

The classes of the malacozoa may be tabulated as follows:

MALACOZOA.

A. MOLLUSCA.

a. Encephala.
Class 1. Cephalopoda.
Class 2. Pteropoda.
Class 3. Gastropoda.
Class 4. Scaphopoda.

b. Acephala.
Class 5. Pelecypoda.

B. MOLLUSCOIDA.

Class 1. Brachiopoda.
Class 2. Tunicata.
Class 3. Bryozoa.

The systematic arrangement of natural objects, says Woodward, ought not to be guided by convenience, nor framed merely for the purposes of easy remembrance and communication. The true method must be suggested by the objects themselves, by their qualities and relations;—it may not be easy to learn, it may require perpetual modification and adjustment—but inasmuch as it represents the existing state of knowledge, it will aid in the understanding of the subject, whereas a dead and arbitrary arrangement is a perpetual bar to advancement, containing in itself no principle of progression.

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* The acceptance of the view originally propounded by Steenstrup and so ably urged by Professor Morse, respecting the affinities of the brachiopods with the worms (Proc. Bost. Soc. Nat. Hist., 1873), does not to my mind weaken the opinion I have always held as to their affinities with the Polyzoa (Bryozoa), on the one hand, and with the higher mollusca on the other."—*Huxley*, *Anat. of Invert. An.*, 468.

ANATOMY OF THE MOLLUSCA.

EXTERNAL FEATURES.

The CEPHALOPODA are immediately distinguished from all other classes of the mollusca by the circle of *acetabula or arms* (xxiii), which surrounds the head; these were formerly regarded as homologous with the foot of the gastropods, with its margins produced into the eight or ten processes which are indifferently designated as arms, acetabula or brachia, but the *siphon* (xxiii, 9), is more largely used as an organ of locomotion than are the arms, and its ventral position, as well as the distribution of the nerves, indicate that it, rather than the arms, is the homologue of the foot of the gastropod.

The mouth is supplied with a pair of calcareous or horny jaws, resembling in form the beaks of a parrot (ix, 93, 95). The arms proper, in the naked cephalopods, are eight in number, and are distinctively called sessile arms, to distinguish them from the *tentacular arms* or tentacles, much longer, and capable of retraction within pouches, which are additionally possessed by those species which have an internal shell or cuttle-bone. The sessile arms are provided with suckers (xxiii, 4), or hooks for prehension, covering their internal surface, whilst the tentacles are expanded into club-shaped terminations similarly armed (xxv, 20). In the Nautilus, sole living representative of an exceedingly numerous extinct order, the arms degenerate into numerous tentacles (iv, 62, 63), unarmed, which are retractile into eight sheaths, morphologically representing the typical eight arms. In this animal only, the body is contained within, and protected by, an external shell, which compensates to it the loss of the offensive and locomotive powers possessed by its more highly organized allies.

Behind the arms, the circle of which may constitute its crown, that major portion of the head is situated which is usually distinctively so designated; its dorsal aspect exhibits on either side an eye. The head may be joined to the body by a more or less constricted neck, or is frequently sessile upon the latter, without intervening constriction. The body, or mantle, is dorsally more or less continuous with the head, but ventrally forms a sack anteriorly open, and from which emerges the funnel or siphon. The sack or body is, in a small portion of the octopod and in the decapod species, expanded into postero-lateral membranes, possessing the power of undulatory motion, and which may be considered as the equivalent of fins, in function, though not in appearance.

The body in the GASTROPODA presents the following more or less differentiated portions:

1. *Head.* This is sometimes partially separated from the body by an intervening constriction or neck, but is very frequently only indicated by the possession of a mouth on its ventral and of a pair of tentacles on its dorsal surface. From the latter sometimes proceed pedicels bearing the eyes.

2. *Mantle.* This covers the posterior portion of the dorsal surface of the body.

3. *Foot.* The ventral surface of the body, or a specialized portion of it.

The *mouth* may be either simple, in the plane of the head, or it may be produced at the end of a contractile *rostrum*, or of a retractile *proboscis* (xvi, 91). Behind the head and on the under side of what may be called the *neck* is attached the foot, and behind the neck begins the posterior portion of the body covered by the mantle; this part of the animal is very long, usually, and as the shell is moulded upon it, it assumes a similar form—generally spiral. However, in Patella and similar limpet-like shells, the body is short and straight. The mantle encircles the body like a *collar* below, but above it is much produced over the back of the animal, and the respiratory cavity forms a *sinus* of its margin. The foot consists of the attachment to the neck, which is usually narrow, and an expanded portion, sole, or creeping disk. Such is its typical form, but in Patella, etc., the foot includes the entire ventral surface of the animal. It is a muscular process of the body, and the only locomotive organ possessed by gastropods.

Viewed externally, gastropods, as well as the mollusca in general, must be regarded as bilaterally symmetrical; a view which is strengthened by the position of the nervous system, and the developmental history of the intestines: though their actual position, as well as that of the sexual organs, does not correspond with this symmetry. Thus we find that at first the anus is at the posterior end of the body, but gradually it approaches nearer and nearer to the anterior end until finally it opens on the back or right side near the mouth. In its early stages the shell and mantle only occupy the extreme posterior end of the body, but in their growth they cover more and more of the latter, gradually pushing the anus forward.

An external shell, usually sufficiently large to contain the entire animal, is common to most Gastropoda. It is a secretion of the mantle, and conforms to its shape; and the hardness which it assumes by the addition of carbonate of lime, renders it an efficient protection to the animal, whilst the faithfulness with which it reproduces the external features of the latter renders it extremely useful in classifying the mollusca. The spiral growth of shells is as nearly of true mathematical regularity as is possible in an organic body; forming the loga-

rithmic spirals of Moseley, or conchospiral of Naumann. Corresponding to the shell, which is produced by the mantle, and borne by the posterior portion of the body, the posterior dorsal part of the foot bears an operculum, secreted by an expansion of its skin called the *opercular mantle.* Typically, the operculum is a spiral also, but in the same plane; yet in many cases its growth is annular. Usually horny, it is sometimes entirely or partially calcareous, and on the retirement of the animal within the shell it is brought into the aperture of the latter, which it more or less completely closes. Like the shell itself, it may be considered a protective organ, and when in apposition with the former suggests the two enclosing valves of the lamellibranchiate or bivalve mollusks.

Notwithstanding the large portion of the animal which is always within the shell, even when the head and foot are extruded, the latter is only attached to the former at one point, on the columella, and by means of a columellar muscle, which, passing through the foot, is attached at its other end to the operculum (when the latter is developed, which is not always the case). Although there is only this single actual bond of connection between shell and animal, the contact of the body serves to maintain the vitality of the shell, which soon bleaches, and finally decays when separated from its architect and inhabitant.

The Pelecypoda (xxii) differ from the preceding two great classes of the Mollusca in having no specialized head, though provided with a mouth, organs of sight, etc. The foot is a fleshy process adapted by its form to digging rather than to locomotion. The *gills*, arranged on either side the body, the enclosing valves of the testaceous covering, which are united by a hinge dorsally or at their initial point, the arrangement of those organs which are not paired in the median plane of the body—all show that the bivalve mollusk is symmetrical; although in certain attached genera the intestines are crowded into the lower side or valve, the cavity of the valve uppermost in position being usually very shallow.

The security against many enemies which their completely enveloping bivalve shell affords the pelecypoda, and the great proportionate weight of this testaceous covering have tended to produce in these animals a much less active existence than that of the encephala; their movements are slow usually, and the adults of the *attached* families, such as Spondylus, Ostræa, etc., remain for life in one position without possessing the power of changing their residence. The food of the pelecypoda cannot be said to be sought for, but is simply selected from such vegetable and minute animal organisms as the water may float within reach of their mouths. These generally sluggish habits,

with the absence of externally apparent differentiation of parts, organs, or members, has caused the expression "Stupid as an oyster" to be applied to them—an undeserved imputation, as we shall find even the attached oyster, one of the simplest organized of the bivalve mollusca, is well furnished with organs suitable not only for the support, but even for the enjoyment of its placid life—hid though most of these are beneath its enveloping skin or mantle.

THE SKIN.

The epithelium in the dibranchiate cephalopods, is composed of flask-like or rounded grain-like cells; they are cylindrical in Nautilus. Under this lies a thin fibrous layer, which again covers that containing the chromatophores. The skin of the cephalopod, particularly its dorsal surface, is covered with apparently minute specks of a dark reddish color; these are *pigment cells* or *chromatophores* (iv, 60, 61), each provided with radiating muscles, by which, at the will of the animal, the little sacks are greatly dilated, and the color becomes intensified. The rapid chameleon-like changes of color peculiar to the cephalopoda among mollusca, are thus produced; whilst the accompanying opal-like and silvery appearance exhibited by the cuttle-fishes, is due to a thin layer underlying the pigment layer, and reflecting through it. In the tentacles of Nautilus are found epithelial pigment cells, which, according to Rumphius, are used similarly to the chromatophores.

The outer skin, in many of the genera, is furnished with contractile tubercular elevations or *beards*, which are raised when the animal is irritated, and give it a rather ferocious appearance. These beards are disposed in symmetrical patterns, upon the dorsal surface, and particularly around the eyes, and their number and position form distinctive characters of the species.

It will be readily understood, from the above, that color is scarcely characteristic of species in the Cephalopoda. The littoral species of Octopus, etc., which ordinarily await their prey, instead of pursuing it like the finned pelagic species, seem to possess and exercise to some extent through their chromatophores, a power of color mimicry.

The body in the Gastropoda is also completely enveloped by an external more or less elastic skin (iii, 44). Its epithelial layer is formed of quadrangular or prismatic cells, which have a distinct nucleus, and occasionally, when long-cylindrical in form, they have a tail-like end beneath, penetrating the cutis. (Possibly these last are epithelial terminations of nerves—hence sense organs.) Externally the epithelium sometimes supports cilia upon the exposed portions of the body.

The cutis consists essentially of fine interlacing muscular fibres with interposed cells; often attaining a perceptible thickness. The subcutaneous muscular layers of the body are immediately continuous with those of the cutis: the fibres of which they are formed may be clearly distinguished as an outer longitudinal and inner circular layer. These fibres are (as in mollusks generally) compressed and band-like, with pointed ends and central oval nucleus.

In Doris (iii, 39) and some other opisthobranchiates the skin is consolidated and rendered rigid by a number of calcareous spiculæ, which have a somewhat definite arrangement and form a sort of internal skeleton. In Paludina these spicules are replaced by globulous calcareous concretions, in Pholas by siliceous granules. Chalky scales from the cephalopod *Scæurgus titanops* are represented, greatly magnified, by fig. 59, Pl. iv.

The skin forms a fold above and surrounding the foot, and this portion is technically termed the *mantle;* it surrounds the body, behind the cephalic portion like a *collar*, and thence spreads dorsally over the posterior part of the animal. In the terminal, thickened border of the mantle, the cutis becomes of greater thickness; its upper stratum containing very numerous glands, furnishing the mucus and colors which are here mingled with the secreted shell-material. Similar glands, furnishing a copious supply of mucus, are found also in the cephalic portion of the body as well as in the foot, and especially in the sole; but no cells are found in that part of the animal permanently covered by the shell. Frequently, the external skin is colored by a granular pigment, which either is contained in cells, lying between or enveloping the glands, or else sometimes appears to lie free under the epithelium.

The mantle border is the principal agent in the secretion of the shell; it is thrown out by the epithelial layer as a sort of cuticular development. With the organic basis of this secretion is mingled carbonate of lime, originating in the epithelial cells, where it may be separated from the blood; in hardening, the exuded material becomes half crystalline or laminated. Usually the external layer of the shell is a transparent or translucent skin, the epidermis; having no lime in its composition. It is often colored by pigments lying in the outermost border of the mantle.

Whilst the growth of the shell is thus provided for by additions to the aperture margin from the mantle border, the whole mantle is equally capable of producing shelly substance; and not only are shells thus thickened from within by the mantle surface, but breaks are repaired with new material by a similar provision: such repaired and interior portions are devoid of epidermis and of color, the pigments being found only in the free border of the

mantle. Mollusks are even able to secrete shelly matter to provide against threatening dangers from the boring of other animals into their shell. A curious example of shell secretion by the visceral mantle occurs in a cone belonging to the cabinet of the late Dr. Gray. A section of this shell has been made, showing holes bored into the spire end by lithodomi and the repeated walls erected by the animal across the ends of the whorls to protect itself against the ravages of its insidious enemies (i, 8).

The mantle border by means of its sphincter muscles embraces the body closely, thus closing the mantle cavity except at one point, where a small opening allows the ingress and egress of water for respiration. This respiratory opening is a semicircular notch, formed by muscles, and is sometimes prolonged on its dorsal wall into a half-closed tube or respiratory *siphon* (xvi, 89), which, when present, assists by the phases of its development in the classification of the mollusca. This siphon usually forms an anterior notch in the shell near the margin of the columella and the existence of the latter thus predicates that of the former. The siphonal tube is sometimes greatly prolonged, and is then frequently covered for most or all its length by a prolongation of the aperture, which is technically known as the canal of the shell. The canal in Murex and Fusus is extremely long, at least in the typical species. Mollusks of which the shells are furnished with a canal or anterior notch are called *siphonostomata*, the first great division of the prosobranchiate gastropods. The siphon is principally confined to predatory or carnivorous mollusks. In the second great division, termed *holostomata*, the shells have rounded apertures; consequently no siphon but simply an opening for respiration. They are vegetable feeders usually (Natica is a remarkable exception), and close the aperture of the shell completely by an operculum.

At the posterior left border of the mantle, behind the branchiæ, is sometimes an opening from which a small siphon extends backwards, and when it is present, it forms a notch in the posterior part of the shell, as in Cypræa and Conus, or a canal as in Ovula, (lxi), or frequently it only forms a callosity on the upper part of the columella, close to its junction with the posterior part of the aperture margin. This siphonal opening serves for the exit of the water that has entered by the branchial opening.

The mantle border can usually be freely withdrawn within the whorl, as it is not united to the shell at any point. It is frequently prolonged into digitations, or exhibits prominences or invaginations, all of which develop similar features on the shell; thus giving rise to the fingers of Pteroceras, the spines of Murex, etc. Occasionally, however, processes of the mantle do not secrete shelly coverings (iii, 45). Cerithium and the oriental

Melanians, for instance, have delicately digitated mantle margins, these digitations forming no secretion, and sometimes thrown back over the shell.

The mantle is occasionally largely developed into side lobes which in Marginella and Cypræa are so extended as to be habitually thrown up over the external surface of the shell, nearly or completely covering it: in such shells an epidermis is not present. The mantle lobes of Cypræa are beset with numerous papillæ, which seem to partake the function of tentacles as tactile organs (lxi, 99). In other genera, as in Oliva, the mantle is prolonged into filiform processes before and behind (iii, 46).

The female Vermetus has the mantle cleft in the middle, according to Lacaze-Duthiers, although there is no corresponding cleft in the shell, and in Haliotis a similar mantle cleft impresses a groove in the shell, in which are situated the row of holes characteristic of the genus. The shell of Pleurotoma also has a sinus corresponding to a cleft mantle. The cause of the sutural sinus of the shell of the American fresh-water genus Schizostoma is as yet unknown; it may be due to a similar cause or it may be sexual. As the genus is restricted to the Coosa River and its neighborhood, I am inclined to think that it is a local disturbance of growth, especially as most of the species could not be distinguished from corresponding forms of Goniobasis except by the lip notch or slit.

The velum or natatory organ is a temporary lobe of the skin, developed in the larval forms of certain gastropods as well as in pelecypods (xx, 52).

The skin in the latter class is usually smooth, except that the foot in certain boring species develops siliceous granules. The double siphons are parallel prolongations of the mantle margin in certain bivalve mollusks, the superior siphon being excretory, and the inferior one for inspiration (iii, 50).

THE SHELL.

The relation of the shell to the breathing organ is very intimate: indeed, it may be regarded as a *pneumo-skeleton*, being essentially a calcified portion of the mantle, of which the breathing organ is at most a specialized part. In its most reduced form it is only a hollow cone, or plate, protecting the breathing organ and heart, as in Limax, Testacella, Carinaria. Its peculiar features always relate to the condition of the breathing organ; and in Terebratula and Pelonaia it becomes identified with the gill. In the nudibranchs the vascular mantle performs wholly or in part the respiratory office. In the cephalopods the shell becomes complicated by the addition of a distinct, internal,

chambered portion (phragmocone), which is properly a visceral skeleton; in Spirula the shell is reduced to this part.

The shell is so characteristic of the mollusca that they have been commonly called "testacea" (from *testa*, "a shell") in scientific books; and the popular name of "shell-fish," though not quite accurate, cannot be replaced by any other epithet in common use. In one whole class, however, and in several families, there is nothing that would be popularly recognized as a shell.

The study of the shell is of great zoological importance, as its form and composition vary characteristically in the different genera; and it becomes still more important geologically, inasmuch as it is almost the only portion of the vast number of fossil species which has been preserved to us; and by the study of it in comparison with recent species, we are enabled not only to distinguish the species and genera of these extinct forms, but even to predicate the external appearance, the anatomy, the physiology of the animals, with nearly the accuracy with which the vertebrate palæontologist reconstructs a mammal or a reptile from its osseous fragments.

Shells are said to be *external* when the animal is contained in them, and *internal* when they are concealed in the mantle; the latter, as well as the shell-less species, being called *naked* mollusks.

Three-fourths of the mollusca are *univalve*, or have but one shell; the others are mostly *bivalve*, or have two shells; the Pholads have accessory plates, and the shell of Chiton consists of eight pieces. Most of the *multivalves* of old authors were articulate animals (cirripedes), erroneously included with the mollusca, which they resemble only in outward appearance.

All, except the Argonaut, acquire a rudimental shell before they are hatched, which becomes the *nucleus* of the adult shell; it is often differently shaped and colored from the rest of the shell, and hence the *fry* are apt to be mistaken for distinct species from their parents.

In Cymba (i, 15), the nucleus is large and irregular; in *Fusus antiquus* it is cylindrical; in the Pyramidellidæ it is oblique; and it is spiral in Carinaria, Atlanta, and many limpets, which are symmetrical when adult.

The rudimentary shell of the nudibranchs is shed at an early age, and never replaced. In this respect the molluscan shell differs entirely from the shell of the crab and other articulate animals, which is periodically cast off and renewed.

In the bivalves the embryonic shell forms the *umbo* of each valve (ii, 31); it is often very unlike the after-growth, as in Unio, Cyclas, and Hinnites. In attached shells, like the oyster and

Anomia, the umbo frequently presents an exact imitation of the surface to which the young shell originally adhered.

Shells are composed of carbonate of lime, with a small proportion of animal matter. The source of this lime is to be looked for in their food. Modern inquiries into organic chemistry have shown that vegetables derive their elements from the mineral kingdom (air, water, and the soil), and animals theirs from the vegetable. The sea-weed filters the salt water, and separates lime as well as organic elements; and lime is one of the most abundant mineral matters in land plants. From this source the mollusca obtain lime in abundance, and, indeed, we find frequent instances of shells becoming unnaturally thickened through the superabundance of this earth in their systems. On the other hand, instances occur of thin and delicate-shelled varieties in still, deep water, or on clay bottoms; whilst in those districts which are wholly destitute of lime, there are no mollusca. Helices sometimes form cavities in limestone rocks, and M. Bouchard-Chantereaux supposes the foot of the animal to exude an acid solvent which effects the excavation; but Dr. Fischer shows that the jaw and tongue only are probably employed for this purpose, and that the material excavated is used in the formation of shell by the animal. So imperious is the necessity for this material, that Limnæans brought up in captivity, devour the shells of their companions in order to obtain it. M. Gassies, who has raised many terrestrial mollusks, never fails to place pieces of limestone in their cages, and these are eroded more or less rapidly by the needs of the growing Helices. Omitting to provide the limestone, the growth of the shell is retarded or arrested.

The texture of shells is various and characteristic. Some, when broken, present a dull lustre like marble or china, and are termed porcellanous; others are pearly or nacreous; some have a fibrous structure; some are horny, and others glassy and translucent (i, 1).

The nacreous shells are formed by alternate layers of very thin membrane and carbonate of lime, but this alone does not give the pearly lustre, which appears to depend on minute undulations of the layers (i, 2). This lustre has been successfully imitated on engraved steel buttons. Nacreous shells, when polished, form "mother-of-pearl;" when digested in weak acid they leave a membranous residue which retains the original form of the shell. This is the most easily destructible of shell-textures, and in some geological formations we find only casts of the nacreous shells, whilst those of fibrous texture are completely preserved.

Pearls are produced by many bivalves, especially by the Oriental pearl-mussel *Avicula margaritifera* (i, 9), and one of

the common river mussels (*Margaritana margaritifera*). They are also found occasionally in the common oyster, in Anodonta, Unio, *Pinna nobilis*, *Mytilus edulis*, or common mussel, and in *Spondylus gæderopus*. In these they are generally of a green or rose color. The pearls found in *Arca Noæ* are violet, and in *Anomia cepa* purple. They are similar in structure to the shell, and, like it, consist of three layers; but what is the innermost layer in the shell is placed on the outside in the pearl. The iridescence is due to light falling upon the out-cropping edges of partially transparent corrugated plates. The thinner and more transparent the plates the more beautiful is the iridescent lustre; and this is said to be the reason why sea pearls excel those obtained from fresh-water mollusks. Besides the furrows formed by the corrugated surface there are a number of fine dark lines ($\frac{1}{7700}$ inch apart), which may add to the lustrous effect. In some pearls these lines run from pole to pole like the longitudes on the globe; in others they run in various directions; and in a few the lines on the same pearl have different directions, so that they cross each other. The nucleus frequently consists of a fragment of a brownish-yellow organic substance, which behaves in the same way as epidermis when treated with certain chemical reagents. Sand is generally said to be the nucleus; but this is simply a conjecture which has gradually become regarded as a fact; it is quite the exception for sand to be the nucleus; as a general rule it is some organic substance. In some districts one kind of nucleus seems to be more common than another; at least, this is how the different results obtained by observers in different localities may be explained. Filippi (*Sul' origine delle Perle*, translated in Müller's *Archiv*, 1856) found the parasitic helminth Distoma to be the nucleus in many Anodontas; Kuchenmeister found that the pearls were most abundant in the mollusks living in the still parts of the River Elster, where the water-mites (*Limnochares anodontæ*) existed most numerously. The most generally prevalent nucleus appears to be the bodies or eggs of minute internal parasites, such as Filaria, Distoma, Buchephalus, etc. Completely spherical pearls can only be formed loose in the muscles or other soft parts of the animal. The Chinese obtain them artificially by introducing into the living mussel foreign substances, such as pieces of mother-of-pearl fixed to wires, which thus become coated with a more brilliant material. The relief figures of idols in pearl which ornament the interior of Chinese species of Dipsas (i, 10) are a deposit of nacreous material made upon metal forms introduced between the shell and mantle; they are produced in about a year. The manufacture of pearls is a large industry in China; the process was discovered by a native of Hutchefu in the thirteenth century. European

attempts to procure pearls in this manner have not been financially successful.

Similar prominences and concretions—pearls which are not pearly—are formed inside porcellaneous shells: these are as variable in color as the surfaces on which they are formed.

The fibrous shells consist of successive layers of prismatic cells containing translucent carbonate of lime: and the cells of each successive layer correspond, so that the shell, especially when very thick (as in the fossil Inoceramus and Trichites), will break up vertically into fragments, exhibiting on their edges a structure like arragonite, or satin-spar. Horizontal sections exhibit a cellular network, with here and there a dark cell, which is empty (i. 3).

The oyster has a laminated structure, owing to the irregular accumulation of the cells in its successive layers, and breaks up into horizontal plates.

In the boring-shells (Pholadidæ) the carbonate of lime has an atomic arrangement like arragonite, which is considerably harder than calcareous spar: in other cases the difference in hardness depends on the proportion of animal matter and the manner in which the layers are aggregated.

In many bivalve shells there occurs a minute tubular structure, which is very conspicuous in some sections of Pinna and oyster-shell. This tubular structure is frequently occasioned by the growth of a confervoid sponge, hence great care is required in determining whether the perforations are an essential part of the shell.

The Brachiopoda exhibit a characteristic structure by which the smallest fragment of their shells may be determined; it consists of elongated and curved cells matted together, and often perforated by circular holes, arranged in quincunx order (i, 5).

But the most complex shell-structure is presented by the porcellanous Gastropoda. These consist of three strata which readily separate in fossil shells, on account of the removal of their animal cement (i. 6, 7). Each of these three strata is composed of very numerous vertical plates, like cards placed on edge; and the direction of the plates is sometimes transverse in the central stratum, and lengthwise in the outer and inner (as in Cypræa, Cassis, Ampullaria, and Bulimus), or longitudinal in the middle layer and transverse in the others (*e. g.* Conus, Pyrula, Oliva, and Voluta).

Each plate, too, is composed of a series of prismatic cells, arranged obliquely (45°), and their direction being changed in the successive plates, they cross each other at right-angles. Tertiary fossils best exhibit this structure, either at their broken edge, or in polished sections.

The argonaut-shell and the bone of the cuttle-fish have a

peculiar structure; and the Hippurite is distinguished by a cancellated texture, unlike any other shell, except perhaps some of the Cardiaceæ and Chamaceæ.

Epidermis. All shells have an outer coat of animal matter called the "epidermis" (or *periostracum*), sometimes thin and transparent, at others thick and opaque. It is thick and olive-colored in all fresh-water shells and in many Arctic sea-shells (*e. g.* Cyprina and Astarte); the colors of the land-shells often depend on it; sometimes it is silky as in *Helix sericea*, or fringed with hairs as in Trichotropis; in the whelk and some species of Triton and Conus it is thick and rough, like coarse cloth, and in some Modiolas it is drawn out into long beard-like filaments.

In the cowry and other mollusks with large mantle lobes the epidermis is more or less covered up by an additional layer of shell deposited externally.

The epidermis has life, but not sensation, like the human scarf-skin; and it protects the shell against the influence of the weather and chemical agents; it soon fades or is destroyed after the death of the animal in situations where, whilst living, it would have undergone no change. In the bivalves it is organically connected with the margin of the mantle.

It is most developed in shells which frequent damp situations, amongst decaying leaves, and in fresh-water shells. All fresh waters are more or less saturated with carbonic acid gas, and in limestone countries hold so much lime in solution as to deposit it in the form of tufa on the mussels and other shells. But in the absence of lime to neutralize the acid the water acts on the shells, and would dissolve them entirely if it were not for their protecting epidermis. As it is, we can often recognize fresh-water shells by the erosion of those parts where the epidermis was thinnest, namely, the points of the spiral shells and the umbones of the bivalves, those being also the parts longest exposed. Specimens of Melanopsis and Bithynia become truncated again and again in the course of their growth, until the adults are sometimes only half the length they should be, and the discoidal Planorbis sometimes becomes perforated by the removal of its inner whorls; in these cases the animal closes the break in its shell with new layers. Some of the Unios thicken their umbones enormously, and form a layer of animal matter with each new layer of shell, so that the river action is arrested at a succession of steps.* But the action of an acid is certainly not the only cause of erosion; it is assisted by the ravages of various boring animals in some cases, and is frequently largely

* On erosion of fluviatile shells, see Dr. James Lewis, Bost. Soc. Proc., vi, 149.

caused by the wants of the mollusks themselves, which in waters not sufficiently charged with lime are compelled to devour the unoccupied and unprotected parts of their neighbors' houses to obtain material for the enlargement of their own. *

Formation and Growth of the Shell. The shell, as before stated, is formed by the mantle; indeed, each layer of it was once a portion of the mantle, either in the form of a simple membrane or as a layer of cells; and each layer was successively calcified (or hardened with carbonate of lime) and thrown off by the mantle to unite with those previously formed. Being extravascular it has no inherent power of repair.

The epidermis and cellular structures are formed by the margin (or collar) of the mantle; the membranous and nacreous layers, by the thin and transparent portion which contains the viscera; hence we find the pearly texture only as a lining inside the shell, as in the Nautilus, and all the Aviculidæ and Turbinidæ.

If the margin of a shell is fractured during the lifetime of the animal, the injury will be completely repaired by the reproduction both of the epidermis and of the outer layer of shell with its proper color. But if the apex is destroyed, or a hole made at a distance from the aperture, it will merely be closed with the material secreted by the visceral mantle. Such inroads are often made by boring worms and shell, and even by a sponge (Cliona), which completely mines the most solid shells.

Lines of Growth. So long as the animal continues growing, each new layer of shell extends beyond the one formed before it; and, in consequence, the external surface becomes marked with lines of growth. During winter, or the season of rest which corresponds to it, shells cease to grow; and these periodic resting-places are often indicated by interruptions of the otherwise regular lines of growth and color, or by still more obvious signs. It is probable that this pause, or cessation from growth, extends into the breeding season; otherwise there would be two periods of growth and two of rest in each year. In many shells the growth is uniform; but in others each stage is finished by the development of a fringe, or ridge, *varix* (xlvi, 54, 55), or of a row of spines, as in Tridacna and Murex.

Adult Characters. The attainment of the full growth proper to each species is usually marked by changes in the shell.

Some bivalves, like the oyster and Gryphæa, continue to increase in thickness long after they have ceased to grow outwards; the greatest addition is made to the lower valve, especially near the umbo; and in the Spondylus some parts of the mantle

* *Fischer, Actes Linn. Soc. Bord.*, xviii.

secrete more than others, so that cavities, filled with fluid, are left in the substance of the shell.

At maturity the Teredo and Fistulana close the extremity of their calcareous tubes completely, whilst the Aspergillum closes its tube with its characteristic porous or sieve-like disk. The genera of Jonannetinæ, near allies of the above remarkable bivalves, have in youth a largely developed foot, but at maturity this organ undergoes a retrogressive metamorphosis, becomes atrophied, and is closed in by a calcareous deposit which connects the originally gaping shelly valves into a closed club-shaped tube. Other bivalves, as the symphynote Unios and Pinna, solder their dorsal line or a portion of it so that continued motion of the valves would be impossible, only that in the first a rupture of one of the soldered wings takes place near its base, so that one of the valves carries both wings whilst the adductors have recovered their power. In Pinna the elasticity of the shell allows some action to the adductor, notwithstanding the symphynote hinge-line. Mulleria, which is dimyary and locomotive when young, becomes fixed and monomyary when adult, and it solders both the young valves to the beak of the fixed valve whilst the other is free and subject to the action of the adductor.

A condition similar to the Pholades occurs in the adult Rhizochilus (xliv, 33). Dr. Gray remarks of this singular genus that "the shell, while the animal is growing, is free; but when the animals have arrived at their full development, two or more congregate together in groups, each animal forming a more or less irregular, opaque, white, solid shelly extension of the outer and inner lip clasping the axis of the coral, *Antipathes ericoides*, or the neighboring shells, or both, and at length entirely closing the mouth of the shell, and firmly attaching the shells to the coral, or to one another, in such a manner that the animal is completely surrounded by a solid shelly case, having no communication with the outer world but through the case of the anterior siphon of the mantle, which, by the contraction of the mouth of the shell, has been converted into a shelly tube. This self-immurement of the animal within its shell has not been described in any other mollusk, and one is led to inquire if by so doing the animal commits voluntary suicide or has a prolonged existence; if the latter, one should expect that it must be of a very torpid or lingering description, as the animal is entirely precluded from procuring its usual or indeed any other food for its subsistence, and the supply of water for respiration which can enter by the single siphon must be of a very limited quantity, there being only one aperture for its entrance and exit. Many of the lung-breathing mollusca cover the mouth of their shell after the animal is withdrawn during very dry weather with a membranaceous or calcareous epiphragm, the animal during

the time sinking into a torpid condition; but these animals have the power, at the first recurrence of damp weather, to remove this cover, which is not the case with the hard shelly secretions which cover up the mouth of the shell of Rhizochilus."*

Notwithstanding the decided opinion given by Dr. Gray that the self-immurement of the Rhizochilus is permanent, I cannot help thinking that it only continues during a period of hibernation, and as many mollusks have the power of absorbing away partitions in their shells, as well as parts of the columella and the interior thickening of the outer lip, it appears to me that his argument that the hardness and thickness of the prison-walls would prevent escape, can scarcely be sustained.

In certain species of Calyptræa and in Hipponix the foot is atrophied. The mantle secretes not only the shell which covers the animal, but also, from its ventral face a calcareous base attached to some foreign body, and to this the mollusk adheres by a horseshoe-shaped muscle.

Magilus (xlv, 52) resembles the Teredos in constructing a tube, and for the same purpose. In Magilus the tubular growth is, however, a continuation of the growth of the shell margin, but changed in form, and in this respect it is more like the Aspergillum, which builds out a tube from the valves which lay open near the end and form part of its circumference.

A more or less irregular unrollment of the spiral takes place in Vermetus (lxvii, 68) and its allies, and to a less degree in certain Cuban Cylindrellæ and some other terrestrial mollusks. In the terrestrial genera Hypselostoma, Tomigerus and Anostoma, the adult character is proclaimed by a very curious change in the progression of the spiral by which the mouth of the shell is turned upwards to its superior or spire face: so in certain South American Bulimi the saccate body-whorl of the adult is deflected from the axis of the spire-whorls.

Sculptured shells, particularly Ammonites, and species of Rostellaria and Fusus, often become plain in the last part of their growth. But the most characteristic change is the thickening and contraction of the aperture in the univalves. The young cowry has a thin, sharp lip (lxi, 97), which becomes curled inwards, and enormously thickened and toothed in the adult; the Pteroceras (lix, 63) develops its scorpion-like claws only when full-grown; and the land snails form a thickened lip, or narrow their aperture with projecting processes, so that it is a marvel how they pass in and out, and how they can exclude their eggs.

Yet at this time they would seem to require more space and accommodation in their houses than before, and there are several

* Ann. Mag. Nat. Hist., 2d ser., vii, 477, 1851.

curious ways in which this is sometimes obtained. The Neritidæ, Helicinidæ and Auriculidæ (l, 14) dissolve all the internal spiral column of their shells; the cone (i, 8) removes all but a paper-like portion of its inner whorls; the cowry goes still further, and continues removing the internal layers of its shell-wall, and depositing new layers externally with its overlapping mantle (lxi, 99), until, in some cases, all resemblance to the young shell is lost in the adult.

The power which mollusks possess of dissolving portions of their own shells is also exhibited by the Murices in removing those spines from their whorls which interfere with their growth; and by the Purpura and others in wearing away the inner wall of their aperture.

Decollated Shells. It frequently happens that as spiral shells become adult they cease to occupy the upper part of their cavity; the space thus vacated is sometimes filled with solid shell, as in Magilus; or it is partitioned off, as in Vermetus, Euomphalus, Turritella, Triton or Cæcum (i, 11). The deserted apex is sometimes very thin, and becoming dead and brittle, it breaks away, leaving the shell truncated or decollated. This happens constantly with the Truncatellæ, Cylindrellæ (i, 12, 13), and *Bulimus decollatus;* amongst the fresh-water shells it depends upon local circumstances, but is very common with Pirena and Cerithidea.

Decollated shells usually have the whorls of the spire closely wound and not increasing much in diameter. Before the truncation takes place the partition or septum is formed which is intended to close the new summit. A number of tropical and subtropical terrestrial species, particularly of America, uniformly truncate their shells, the portion closed off from contact with the mollusk becoming dead and fragile so as to break away readily. M. Gassies has, however, observed *Rumina decollata* strike with the summit of its shell, with the evident purpose of fracturing it. In Cæcum also (i, 11), which commences growth as a spiral shell, a septum is formed soon after the close spire has been exchanged for a simply curved tube, and then the spire is detached. As the shell progresses in its growth another septum is formed and again it suffers truncation at its initial end, so that the adult Cæcum is a simple curved tube, differing from the Scaphopoda or Dentalium shells in the small end being closed instead of open, as in the "tooth shells." In the latter the posterior opening is for the extrusion of the eggs—which in these only, among encephalous mollusca, are accommodated with a separate aperture in the shell for their passage.

Forms of Shells. These will be described particularly hereafter; enough has been said to show that in the molluscan shell (as in the vertebrate skeleton) indications are afforded of many

of the leading affinities and structural peculiarities of the animal. It may sometimes be difficult to determine the genus of a shell, especially when its form is very simple; but this results more from the imperfection of our technicalities and systems than from any want of co-ordination in the animal and its shell.

Monstrosities. The whorls of spiral shells are sometimes separated by the interference of foreign substances, which adhere to them whilst young; the garden-snail has been found in this condition, and less complete instances are common amongst sea shells. Discoidal shells occasionally become spiral [as in Planorbis (i, 18)], or irregular in their growth, owing to an unhealthy condition. The discoidal Ammonites sometimes show a slight tendency to become spiral, and more rarely become unsymmetrical, and have the keel on one side instead of in the middle. Helices occasionally occur with tilted whorls, or even more or less unwound and scalariform (i, 16, 17).

All attached shells are liable to interference in their growth, and malformations consequent on their situation in cavities, or from coming in contact with rocks. The *Dreissena polymorpha* distorts the other fresh-water mussels by fastening their valves with its byssus; and balani sometimes produce strange protuberances on the back of the cowry, to which they have attached themselves when young. In the British Museum there is a *Helix terrestris* (Chemn.) with a small stick passing through it, and projecting from the apex and umbilicus. Mr. Pickering has, in his collection, a *Helix hortensis* which got entangled in a nut-shell when young, and growing too large to escape, had to endure the incubus to the end of its days. Fischer speaks of a *Helix aspersa*, which has entangled in its aperture a younger shell of the same species, which it has soldered fast, thus bearing two shells. Cailliaud has produced monsters by bringing dead shells in contact with growing ones.

In the miocene tertiaries of Asia Minor, Professor Forbes discovered whole races of Neritina, Paludina, and Melanopsis, with whorls ribbed or keeled, as if through the unhealthy influence of brackish water. The fossil periwinkles of the Norwich Crag are similarly distorted, probably by the access of fresh water; parallel cases occur at the present day in the Baltic.

Reversed Shells. Left-handed or reversed varieties of spiral shells have been met with in some of the very common species, like the whelk and garden-snail, and in some localities tend to become hereditary. *Bulimus citrinus* is as often sinistral as dextral; and a reversed variety of *Fusus antiquus* was more common than the normal form in the pliocene sea. Other shells are normally sinistral, as in many species of Pupa, and the entire genera Clausilia, Physa, and Triforis. Bivalves less distinctly exhibit variations of this kind; but the attached valve of Chama

has its umbo turned to the right or left indifferently; and of two specimens of *Lucina Childreni* in the British Museum, one has the right, the other the left valve flat.

Colors of Shells. These are usually confined to the surface beneath the epidermis, and are secreted by the border of the mantle, which often exhibits similar tints and patterns (e. g. *Voluta undulata*, liii, 14). Occasionally the inner strata of porcellanous shells are differently colored from the exterior, and the makers of shell-cameos avail themselves of this difference to produce white or rose-colored figures on a dark ground. Cameos carved on the shell of *Cassis cornuta*, are white on an orange ground; on *C. tuberosa*, and *Madagascariensis* (lxii, 22), white upon dark claret-color; on *C. rufa*, pale salmon-color on orange; and on *Strombus gigas* (lix, 57), yellow on pink. By filing some of the olives (e. g. *Oliva utriculus*) they may be made into very different colored shells.

The secretion of color by the mantle depends greatly on the action of light; shallow-water shells are, as a class, warmer and brighter-colored than those from deep water; and bivalves which are habitually fixed or stationary (like Spondylus and *Pecten pleuronectes*) have the upper valve richly tinted, whilst the lower one is colorless. The backs of most spiral shells are darker than the under sides; but in Ianthina the base of the shell is habitually turned upwards, and is deeply dyed with violet. Some colors are more permanent than others; the red spots on the Naticas and Nerites are commonly preserved in tertiary and oolitic fossils, and even in one example (of *N. subcostata*, Schl.) from Devonian limestone. *Terebratula hastata*, and some Pectens of the Carboniferous period, retain their markings; the *Orthoceras anguliferus* of the Devonian beds has zigzag bands of color; and a Terebratula of the same age, from Arctic North America, is ornamented with several rows of dark red spots.

The Operculum. Most spiral shells have an operculum, or lid, with which to close the aperture when they withdraw for shelter (xliii, 7). It is developed on a particular lobe at the posterior part of the foot, and consists of horny layers, sometimes hardened with shelly matter.

It has been considered by Adanson, and more recently by Dr. Gray, as the equivalent of the dextral valve of the conchifera; but however similar in appearance, its anatomical relations are altogether different. In position it represents the byssus of the bivalves; and in function it is like the plug with which unattached specimens of Byssoarca close their aperture.

Homologies of the Shell. The shell is so simple a structure that its modifications present few points for comparison; but even these are not wholly understood, or free from doubt. The bivalve shell may be compared to the outer tunic of the ascidian,

cut open and converted into separable valves. In the Conchifera this division of the mantle is vertical, and the valves are right and left. In the Brachiopoda the separation is horizontal, and the valves are dorsal and ventral. The monomyarian bivalves lie habitually on one side (like the Pleuronectidæ among fishes); and their shells, though really right and left, are termed "upper" and "lower" valves. The univalve shell is the equivalent of both valves of the bivalve. In the Pteropoda it consists of dorsal and ventral plates, comparable with the valves of Terebratula. In the Gastropoda it is equivalent to both valves of the Conchifera united above. The nautilus shell corresponds to that of the gastropod; but whilst its chambers are shadowed forth in many spiral shells, the siphuncle is something additional; and the entire shell of the cuttle-fish and argonaut have no known equivalent or parallel in the other molluscous classes. The student might imagine a resemblance in the shell of the Orthoceras to a back-bone. The phragmocone is the representative of the calcareous axis (or splanchno-skeleton) of a coral, such as Amplexus or Siphonophyllia.

Spines and Sculpture. It remains to speak of the sculpture and particularly of the spinous processes which adorn the shells of many univalves, as well as the valves of *Unio spinosus*, *Dione lupinaria*, etc. It is difficult in some cases to imagine the part which these play in the molluscan economy, unless it be to prevent greedy enemies from masticating them without exceeding discomfort. The formation of the spines depends upon folds of the mantle-margin, and regular as is the row of the long needle-like projections which ornament the lateral slope of Dione, they have nevertheless been formed one at a time on either valve at its margin: thus they indicate the periodicity of growth. In most cases marginal characters are absorbed away by the animal before commencing a new growth of its shell, but sometimes they persist both externally and internally—thus the varices of Murex are simply the thickened lips of former mouths, the recurring internal projections in the whorls of Segmentina, *Helix interna*, etc., are the marks of former rest-periods in their growth. Another class of external markings found only upon attached shells, such as Crepidula, Anomia, Myochama, etc., have no connection with the animal which forms them, but result merely from the plasticity of the newly formed shelly exudation, when brought into contact with the surface to which they are attached. Thus it is not unusual to find an Anomia covered with ribs crossing its surface at right-angles, or laterally to its axis of growth in consequence of having been in close contact with a Pecten.

A numerous class of deviations from the normal spiral is found in certain limpet-like mollusks as well as in Haliotis (lxxxiii). In these the spire has been reduced to a simple cone, or to a very

small size compared to the enormously large aperture, which hugs close to rocks, etc., to which the animal attaches itself by its much expanded sole almost as tightly as though it were a specialized sucker. The branchial cavity is placed in communication with the surrounding water in these genera by a special notch in Haliotis (lxxxiii, 10–13), which, by the progressive growth of the shell forms a series of dorsal apertures; the earlier ones finally becoming filled again with shell, but several always remaining open. In Fissurella (lxxxiii, 15), a similar but single aperture exists at the apex of the shell, and in several allied genera a similar provision is made only differing in form and position.

A large volume might readily be filled with interesting particulars concerning the shells of mollusca, but our space will only allow the above rapid resumé of the more important aspects of the subject. It remains to detail briefly the special relations of the shell to each class of mollusks, together with the nomenclature which has been adopted for the ready classification of its diverse forms.

Cephalopoda. An internal shell is found only in the dibranchiate cephalopods, and amongst them only fully developed in the decapod division, *i. e.*, among the pelagic species, whose quick movements require the support to the body which the form and position of the shell affords; nevertheless it is prefigured in the cartilaginous blades lodged in the back of the octopods (iv, 56), and is more fully developed in the single octopod genus, Cirroteuthis (iv, 58), which possesses the means of more rapid motion in its largely webbed arms.

The internal shell is simple usually, in form, being a blade or pen lodged in a pouch or slit in the back of the mantle, with an anterior, more or less specialized, prolongation of its rhachis or quill. The internal shell is either horny or chitinous and transparent as in Loligo (xxv, 21), or a spongy, chalky mass, as in Sepia (xxvii, 49), or calcareous, as in the fossil Belemnites (ii, 19, 21), or mother-of-pearl, as in Spirula (xxvii, 52); in the latter, only, taking the spiral form of the external shells of the tetrabranchiate cephalopods.

The feather-shaped horny shell of the Loligo resembles, and is called, a *pen*, and its rhachis, prolonged in front like a quill, completes the resemblance. This rhachis is on the ventral side, when the pen is lodged in the mantle, the wing end being posterior, the quill anterior. The wings, or lateral projections are, commonly, broader in the female than in the male individuals.

When the shell is both corneous and testaceous, as in Sepia, among recent genera and in several fossil forms, it consists of a thin, horny blade, laying beneath the entire dorsal surface of the

mantle, with an underlying spongy calcareous mass attached. In Sepia we find always, the so-called aerial chambers obliquely placed and not connected by a siphon, and sometimes terminated by a sharp rostrum, whilst in fossil genera, as Beloptera, these chambers are arranged in a single line, or in Spirulirostra (xxix, 81), they become a spiral series, connected by a siphon and analogous to the shell of the Spirula (xxvi, 53), which latter lies free in the mantle, without the envelopment of a spongy mass. In another group of fossil forms, the long shell is composed of a narrow or broad anterior corneous portion, and a posterior calcareous part containing the aerial chambers, placed one upon another and siphunculated. These chambers are only covered with shell in Conoteuthis; but they are protected in the Belemnites by a testaceous rostrum (ii, 19); sometimes very long, which, absolutely identical with that of Sepia, is composed of successive very compact radiating layers.

The internal shell, in relation to the animal economy, demands some further consideration. These functions, by reason of modifications of structure, are threefold:

1. If it is a corneous blade, it becomes simply a support to the flesh, fulfilling that office of the skeleton in mammals.

2. When it is corneous or testaceous, and containing parts filled with air, as in the alveola of the Belemnites, it, perhaps, additionally represents among mollusks the swimming-bladder of fishes. These air-chambers may consist, as we have seen, of an oblique series, separated in their interior by a crowd of small diaphragms, filled with air, and attached to the under side of the blade or cuttle-bone, as in Sepia; or even of a series of chambers taking a definite spiral form, as in Spirula. D'Orbigny shows that shells of this second division, when parted from their animals, are sufficiently light to float upon the surface of the waves, and that there is a constant coincidence of the progressive augmentation of the number of air-chambers with the growth of the animal, in order to maintain an equilibrium. The lightness of the shell of the Sepia appears to be partly due to a contained gas, which Dr. Paul Bert has succeeded in obtaining in small quantities, by opening the sack of the animal under water. In effect, the Sepia and the Spirula, animals of massive proportions, have need of this aid in swimming; and it is more plentifully supplied to the round-bodied Spirula, than to the Conoteuthis, for example, the form of which denotes an animal infinitely more agile. In the Belemnites the aerial chambers doubtless compensated the enormous weight of the calcareous rostrum, which would otherwise have compelled the animal to maintain a vertical position in the water, or prevented horizontal movement, except at great disadvantage to its strength. (In the chambered external shells of the tetrabranchiates, represented

amongst the extinct genera by the spirally-coiled Ammonites, and other genera, and largely developed in species, but of which the Nautilus is the sole recent example, the air-chambers may possibly compensate the weight of superincumbent water, and facilitate its crawling movements, if, as is now generally supposed, the Nautilus is not a swimming animal, and does not voluntarily leave its ocean-bed. The immense size and weight of the Nautilus shell, capable of containing the entire animal within its last chamber, the absence of long arms, or web or fins, all seem to favor this supposition as to its habits.)

3. Owing to their narrow posterior and massive anterior form, as well as to the normal direction of the siphon and the frequent use of the webbed arms in swimming, the cephalopods are able to progress through the water more rapidly in retrograde than in forward motion; and this swimming is a succession of darts made with great velocity. Here the calcareous rostrum, as in the Sepia, and which is so largely developed in Belemnites and other fossil genera, comes into use as a body-protector, in receiving and withstanding the shocks of accidental collisions. It is only among the swimming species that this protection is needed, and it is most required, and consequently most developed, in those which inhabit the vicinity of the coasts, like the Sepia.

Internal shells, having no aerial chambers, show no nucleus, and do not change their forms at different periods of their growth; but in most of those furnished with the air-chambers, a distinct nucleus is observed, indicated by the more globose first chamber, as in Spirula and Belemnites. Amongst these latter shells we find considerable modifications arising from age, sex or pathological causes. The changes resulting from age are, above all, visible in the rostra of the Belemnites, which, ordinarily slender when young, are. thickened and shortened with advancing age. In exceptional cases, these rostra, when their growth is completed, present, at their extremity, very remarkable tubular prolongations. Modifications due to sex, are shown in the difference in width of the shell in Loligo, in the more or less elongated rostrum of Belemnites, perhaps, or in the prolongations of which we have just spoken. Pathological modifications are very numerous, above all in Belemnites. They may change entirely the form of the rostrum, by rendering it obtuse, or even cause those strange mutilations upon which the genus Actinocamax is founded.

The Spirula is peculiar in being formed exclusively of pearl (the Nautilus has an internal pearly layer); it hangs free in the hinder end of the body, held in place solely by lateral thin lappets of skin proceeding from either side of the mantle, and connate below the whorls, with a prehensile prominence or

sucker at their junction. A small portion of the intestinal sack occupies the last chamber of the shell, and a prolongation of it connects the chambers by passing through the siphonal tubes which penetrate the septa towards their inner margin (instead of in the middle, as in Nautilus).

In the fossil Belemnites, the siphunculated, chambered portion of the shell has been called the phragmoconus, by Owen; the horny or chalky blade is termed, by Huxley, the pro-ostracum, and the rostrum of the latter author corresponds with the similar term heretofore used by us (ii, 19–21).

Analysis shows the horny shell to be principally composed of chitin. The *Sepia officinalis*, according to J. F. John, yields of Carbonate of Lime, with a trace of Phosphate, 85°; Water, 4°; Organic matter, 4°; Residuum, Magnesia, etc., 7°.

M. Munier-Chalmas has recently endeavored to prove that the Ammonites are not tetrabranchiate Cephalopoda, allied to the Nautili, but dibranchiate decapods, having the greatest affinity to the Spirulæ. As early as 1867, Barrande had shown the small resemblance that exists between the Goniatites and the Nautilidæ, during the first period of their development. The initial chamber of the *phragmostracum* in the Nautilidæ, does not sensibly differ, in its general organization, from the other primary chambers which are developed a little later; whereas the initial shell of the Goniatites appears in the form of an egg, isolated from the first air-chamber by a distinct constriction. This initial chamber or *ovisac*, of the Goniatites, so different from those which immediately succeed it, is met with at the origin of the phragmostracum of all the dibranchiate mollusca that M. Munier-Chalmas has been able to study. Mr. Alpheus Hyatt's very interesting investigations upon the embryogeny of the phragmostracum of *Nautilus Pompilius*, *Deroceras planicosta*, and the Goniatites, come in support of these observations. Mr. Hyatt, however, preoccupied by his theoretical ideas upon the evolution of living creatures, in order to establish the affiliation of the Ammonites and Nautili, supposes that the latter lost their ovisac by truncation. To support this supposition, he adduces the transverse external cicatrix which he observed on the initial chamber of *Nautilus Pompilius*. The comparative examination which M. Munier-Chalmas has made of the ovisacs of *Spirula Peronii* and of *Ammonites Parkinsoni*, and other species, has shown that in these mollusks the siphon originates in the ovisac a little before the appearance of the first septum. It commences by a cæcal inflation, which bears the prosiphon in its prolongation. The new organ, to which he gives the name of prosiphon, must take the place of the siphon during the embryonic period. It originates in the ovisac, opposite the siphonal inflation, upon which it terminates, but without having any internal communi-

cation therewith. It is very variable in its general form, and may present strongly marked examples of dimorphism in the same species of Ammonite. It is formed by a membrane, which is sometimes simply spread out as in *Spirula Peronii*, or which may form a more or less circular tube. It also presents two, three, or four small subdivisions at its point of insertion upon the inner wall.

The presence of an ovisac has been ascertained by M. Chalmas in a number of fossil cephalopods, Belemnites, Ammonites, Ceratites, etc. It is generally spheroidal when the turns of the spire are free, and ovoid when they are contiguous. But in the living tetrabranchiate Cephalopoda, as well as in the remains of the many extinct species, the presence of an ovisac has never been detected. In Nautilus and Aturia, the siphon originates upon the inner walls of the first chamber. It is completely closed at its posterior extremity, by a part of the calcareous prolongation of the septum, which assists in its formation. The external transverse cicatrix observed by Mr. Hyatt, can never have been in communication with the siphon; its purpose is still completely unknown. It has been indicated, by Mr. Barrande, upon a great number of Silurian tetrabranchiata.

Thus it results, from these observations, that at the Silurian epoch the tetrabranchiate Cephalopoda were as clearly separated from the dibranchiates, as at the present day. The only modifications that we can recognize are of generic rank; in fact, the Ammonites, which, when young, have septa like those of Doroceras and Goniatites, appear to be derived from one of those types.—*Ann. Mag. N. Hist.*, 4th ser., xiii, 184, 1874 (from *Comptes Rendus*, 1873).

External Shell in the Cephalopoda. Regarding the testaceous nest of the female Argonaut as a shell, it is the only cephalopod genus which is unilocular; in all others the cavity of the external shells is divided by partitions into chambers, connected by a siphon. The Argonaut shell (xxiv, 19), of a peculiar fibrous, corneo-calcareous texture, is distinguished by the want of a distinct nucleus in its infancy, and by its composition of two layers, one placed upon the other. It is secreted by the palmate arms of the female, which are constantly applied to its sides and envelop them (xxiv, 20). In the male Argonaut, always much smaller, there are no palmated arms (xvi, 84, 85), and consequently, no shell. The shell itself appears to be useful only as a portable cradle for the development of the eggs (xviii, 15), and the animal which forms it does not appear to differ greatly from the shell-less Octopus.

The question of the parasitism of the animal of the Argonaut in its shell, originally assumed by distinguished naturalists, has been so long debated, that quite a literature upon the subject has

accumulated. The want of attachment of the animal by adductor muscles, and the fact that the shell itself is not moulded on the animal's body, and does not correspond to its shape were considered such strong evidence of parasitism, that the animal itself was described as Ocythoë, and the shell as Argonauta. The observations of Madame Jeanette Power first set this vexed question at rest, by showing that the animal builds its shell by the exudation of material from the expanded or velamentous arms of the female, instead of from the mantle, as in true shells.

The Argonaut shell, or egg-nest, is structurally composed of small plates or prisms; its earlier portion is covered with a chagrined cuticle, and its toothed periphery is stained with brown. On either side the velamentous dorsal arms are applied to its external surface, and not only do they add to the margin when growth takes place, but they suffice also to renew any broken portion of the already existing walls.

In a specimen of *Argonauta argo*, which forms a part of the collection of Amherst College, a portion has been broken out near the middle of the left side, and not far from the sinus of the aperture. A new deposit of testaceous substance, together with a broken fragment, has closed the opening in the rude manner common in the shells of the mollusca. But the most extraordinary circumstance is that a fragment which was broken out in the accident which befell the animal, now constitutes two-thirds of the repaired portion, and that the original inner surface is now the outer surface, as is evident from its concavity, style of undulation, and texture. It is also nearly at right-angles to its original position. These facts show that the piece was totally detached from the shell by the accident. The vela of the Argonaut, by clasping and enveloping the shell, had evidently prevented the loss of this fragment. It is obvious, also, that the new deposit of testaceous matter was secreted from the part of the animal within the shell, and not from the vela, since the edges of the original shell around the fracture appear exclusively on the outside.—C. B. ADAMS, *Am. Jour. Sci.*, 2 ser., vi, 138, 1848.

Madame Power has seen the fractured shell of an Argonaut partially repaired by membrane in less than six hours.

The subjoined notes of an accurate modern naturalist afford conclusive evidence of the non-parasitism of the Argonaut.

On our passage home across the South Atlantic, I enjoyed numerous opportunities of observing the animals of *Argonauta argo* and *gondola* in the living state, specimens having been captured by us in large numbers by means of a trawl, as they came to the surface of the water at the decline of day in calm weather, in company with Carinaria, Hyalæa, Firola and Cleo-

dora. My observations all tend to prove, as might have been expected, the accuracy of Madame Power's observations on the cephalopodic origin of the shell, and the fanciful nature of the statements of Pliny, Poli, and the poets.

It is quite true that the female Argonaut can readily disengage herself from the shell, when the velamentous arms become collapsed, and float apparently useless on each side of the animal; and it is equally certain that she has not the power, or, more properly, the sagacity to re-enter her nest and resume the guardianship of her eggs. On the contrary, she herself, if kept in confinement, after darting and wounding herself against the sides of the vessel in which she is confined, soon becomes languid, exhausted, and very shortly dies. Numbers of male Argonauts were taken by us, at the same time, without any shells, and this being the season of ovoposition may account for the females, in such a number of instances, being found embracing their calcareous shell-nests, which, so ingeniously formed by the instinct of the mother for the protection of her eggs from injury, resemble, in some measure, those nidimental capsules secreted by many marine gastropods for the preservation of the immature embryo.—ARTHUR ADAMS, Zool. Voy. Samarang, 5, 1850.

The *multilocular* external shells, Nautilus, Ammonites, etc. (iv, 63), distinguish an order of cephalopods breathing by four instead of two branchiæ, and with the arms much reduced in size and subdivided into tentacles. The shells are capable of containing the entire animal in the cavity above the last aerial chamber, to the wall of which it adheres by two strong muscles. These shells are composed of two layers, the external or porcellanous containing the colors, and the internal, which is pearly, and which includes the partitions or *septa*. These septa, which are straight or arcuated in Nautilus, in Orthoceratites, etc., are angulated at the *suture* in Goniatites, and with infinitely ramified lobes in Ammonites (xxxiv, 52), Hamites, Turrilites, and other fossil genera.

The inner pearly layer of the shell, as well as of the septa, is formed by the body of the animal, whilst the outer porcellanous layer is constructed by the mantle-margin. There is additionally deposited, on the spire side of the Nautilus shell, a third thin, black, grainy layer, which can be readily scraped off. This substance can be detected also in many fossil tetrabranchiates.

Sandberger finds the hardness of the porcellanous layer of Nautilus, 4·5 to 5·0; the nacreous layer, 3·5 to 4·0; whilst the specific gravity of the former is 2·565, and of the latter, 1·596.

The structure of the shells of existing testaceous cephalopods is, on the whole, more analogous to that of bivalves than to that of the gastropods, the three layers of perpendicular laminæ, so

characteristic of the latter, being here quite indistinguishable. The shell of Nautilus is the only one in which the presence of two layers is obvious, from their difference of texture. A thin section of the external layer of the shell of *Nautilus Pompilius*, taken parallel to the surface, shows that it is made up of an aggregation of cells of various sizes, those strata which are nearest the surface being the largest. The internal or nacreous layer is also distinctly cellular.

The body of the animal of Nautilus, which is applied to and forms the septum, is of similar smooth and rounded form, and we may reason from analogy that the arborescent lobes of the septum in the fossil Ammonites, were likewise moulded upon a similarly formed surface. If we seek a use for this complication of structure in Ammonites, we shall find a possible explanation in the connecting siphon which, piercing the centres of the septa in Nautilus, enables the animal thereby to strengthen its hold upon its shell, but piercing laterally in Ammonites, gives only an excentric attachment. In the latter case, the lobes and ramifications, applied to the corresponding parts of the animal, would tighten its attachment, and partially remedy the want of the central support.

The outlines of the septa are termed *sutures*, and when these are folded, as in Ammonites, etc., the elevations are called *saddles*, and the depressions, *lobes* (xxxv, 72; ii, 28, 29). This frilling or folding is found principally at the junction of the septum with the shell-wall, the former being nearly flat in the middle, even when its sutural complication is extreme. These parts are subdivided thus: A single *siphonal* or *ventral lobe* surrounds the siphon, and occupies the medial region of the back, and the additional two lobes on either side of it are named the *superior lateral lobes* and *inferior lateral lobes*, whilst other lobes, whatever their number, are called auxiliary lobes; finally, opposed to the *siphonal* is the *antisiphonal lobe*. The saddles bear a corresponding nomenclature, that between the ventral lobe and the superior lateral, being termed the *ventral saddle*, the next the *lateral saddle*, etc.

All multilocular cephalopods have the chambers of their shells connected by a siphon, which traverses the septa, and receives from the latter a series of short investing tubes.

The siphon pierces the middle of the septa in Nautilus (ii. 23), in Orthoceratites, etc., whilst it is near the internal edge in Clymenia (ii, 24), and the outer edge in Goniatites, Ammonites, etc. (ii, 25).

It has been supposed by Buckland, that the siphon, which communicates with a large sack, discovered by Owen, in the body of *Nautilus Pompilius*, may constitute a hydraulic apparatus by which the animal may vary the weight of its shell at will by

introducing water into it; but the narrow calcareous covering which partially confines this tube, preventing dilatation, militates strongly against this hypothesis. D'Orbigny's guess seems more reasonable, that this tube may not only serve as an attachment, but that it may also assist in the formation of a new septum, by keeping filled with compressed air the vacant space, in the rear of the animal, which is to be divided off. Prof. Keferstein, of Göttingen, supposes, also, that the *Nautilus Pompilius*, in order to raise itself in its shell to the place where it designs constructing a new partition, employs the tension of an aeriform fluid, which it produces from the bottom of its sack, and which presses its body upward. The air disengaged by the Nautilus develops a considerable force, because it conquers not only the resistance of weight of the animal itself, but also that of the weight of about six atmospheres, which presses upon it in its habitual station at the bottom of the sea. Prof. Keferstein decidedly agrees with Woodward and others, that the adductor muscle of Nautilus continuously grows forward, and is reabsorbed behind, rather than suddenly moved as supposed by d'Orbigny. Then if these attachments added to that of the continuous horny girdle suffice to hold the animal to its position, the septum, as Woodward shows, would result from a rest-period, and should at least be externally distinguishable among the growth-lines of the exterior surface.

It is only the backs of the septa which are covered with membrane, and this membrane may be required to maintain the vitality of the shell in the deserted chambers. Keferstein also considers it most likely that the siphon serves to maintain the purity of the air in the chambers. The Nautilus may swim, being provided with a locomotive tube or siphon, but it certainly is not well adapted by its structure for that mode of progression, and probably prefers the sea-bed.* Still, the specific gravity of shell and animal so nearly equals that of the sea-water that probably the additional displacement caused by spreading out to the utmost its tentacles would cause it to rise in the water. It is just possible that when the Nautilus issues from its shell the gas contained in the last chamber in the rear of the animal may expand, and so reduce the specific gravity.

The siphuncle is vascular, it opens into the heart-cavity (pericardium), and is most probably filled with fluid from it.

* Mr. A. S. Bickmore, who collected Nautili at Amboina, observes that it has been commonly believed that the Nautilus occasionally rises to the surface, and "setting its sails, floats over the sea." This was first reported by Rumphius, but, after making continued and careful inquiries, he had satisfied himself that there is no reason to suppose that the animal ever rises from the bed of the sea.—*Proc. Bost. Soc. N. H.*, xii, 157, 1868.

Woodward says (Man. Moll., p. 184): "The use of the air-chambers is to render the whole animal (and shell) of nearly the same specific gravity with the water. Thus a *Nautilus Pompilius* in the cabinet of Mr. Morris weighs 1 lb., and when the siphuncle is secured it floats with a half-pound weight in its aperture. The animal would have displaced two pints or 2·5 lbs. of water, and, therefore, if it weighed 3 lbs., the specific gravity of the animal and shell would scarcely exceed that of salt water. The object of the numerous partitions is not so much to sustain the pressure of the water, as to guard against the collisions to which the shell is exposed. They are most complicated in the Ammonites, whose general form possesses least strength. The complicated sutures perhaps indicate lobed ovaries; they occur in genera which must have produced very small eggs. The purpose of the siphuncle (as suggested by Mr. Searles Wood) is to maintain the vitality of the shell during the long life which these animals certainly enjoyed. Mr. Forbes has suggested that the inner course of Hamites broke off as the outer ones were formed. But this was not the case with the Orthocerata, whose long, straight shells were particularly exposed to danger; in these the preservation of the shell was provided for by the increased size and strength of the siphuncle, and its increased vascularity."

The specific gravity of the chambered shells of cephalopods being such as to enable them to float upon the surface of the water, explains the cause of large quantities of shells of Spirula being washed ashore in localities removed many hundreds of miles from the habitat of the animal; it also explains satisfactorily two interesting palæontological facts, namely, the innumerable quantity of fossil shells found in beds which represent ancient beaches, and their absence from those beds which formed sea-bottoms.

External cephalopodous shells are all symmetrical except the genera Turrilites (xxxiii, 37), and Helicoceras; these latter instead of forming a spiral rolled in the same plane, are obliquely spiral; that is, on one side is the projecting spire of the shell, on the other the umbilical opening or axis of the volutions. The symmetrical forms, very numerous, vary all the way from a straight to a coiled growth, their difference in plan of growth constituting the generic distinctions. In some genera a change of form takes place after they have attained a certain age. In Lituites the shell commences with an open spiral (with disjointed whorls), and finally grows in a straight line. In Ancyloceras (xxxii, 33), the commencement is similar, but after elongating the whorl for awhile the extremity is incurved. And in Scaphites (xxxii, 35), a similar mode of growth to Ancyloceras is distinguished nevertheless by the initial spiral whorls being in contact. All other modifications caused by age, do not change

the form but merely the external surface of the shells. Some fossil Nautili, for instance, striated when young, become smooth at a later period, whilst others smooth when young are striated or ribbed when adult. So in the Ammonites, the juvenile shell is always smooth, but in the course of growth, tubercles, ribs and striæ appear, and develop until the animal has become adult; after this period degeneration takes place, the ornaments gradually disappear in the successive growths, and in old age the surface of the outer whorl may be as smooth as in youth. In Ammonites of the same species two forms of shells may be observed, one much compressed, the other swollen; and it is reasonable to conjecture from analogy with living species that the sexes are thus indicated to us, the swollen shell being required for the ovary of the female.

It will be seen from the above that the study of the species of multilocular shells is encompassed with great difficulties, owing to the variability of their characters; in fact the synonymy of the species of Ammonites has been greatly increased in consequence of several names being given to the same species at different periods of its growth.

The living Nautilus also, undergoes a change of form. At a recent meeting of the Boston Society of Natural History, Prof. Bickmore exhibited fifteen shells of *Nautilus Pompilius* of various sizes, from one which measured five-sixths of an inch by one inch and one-sixth in its two diameters, to one measuring two and five-sixths inches by three and three-fourths inches in its two diameters. The smaller ones are so loosely coiled that it is possible to look between the coils. These young specimens therefore represent the loosely coiled Nautiloids of former geological ages; and the *Nautilus Pompilius* at the different stages of its growth is an epitome of the whole group.

The *body-chamber* is always very capacious; more than double the size of the combined air-chambers in *Nautilus Pompilius* (iv, 63), it includes in some Ammonites (ii, 27, 28), more than an entire whorl of the shell. The margin of the aperture, somewhat sigmoid and simple in Nautilus, has projections or extensions in some fossil species; and in Phragmoceras and Gomphoceras (xxx, 100–1), the aperture is even so considerably contracted as to have led to the supposition that the animal was not able to withdraw its head and tentacles within the shell.

In these curious silurian forms M. Barrande thinks that the neck was inclosed in the upper part of the aperture, the lateral lobes giving passage to arms, and the lower lobe to the funnel. But there is some reason to believe that many of the fossil Ammonites possessed a more effective method of closing their aperture; namely, a horny or shelly operculum. In the Nautilus the union and expansion of the two dorsal arms forms a disk or

so-called *hood* (iv, 62), by which the animal may close the aperture of the shell, and in the body-chamber of many of the Ammonites (possibly secreted by these dorsal arms) there are opercular-shaped bodies (ii, 33). The true nature of these shelly or flexible horny plates has not been authoritatively settled however; they have been described under the names of Aptychus and Münsteria as bivalve shells, and have, also, been thought to be cirripeds and even products of the neck-cartilages, of the nidimental gland, gizzards, or ventrally placed cuttle-bones! of Ammonites. In the Arietes group of Ammonites the aptychus is a single, horny, flexible piece, whilst in other groups it is shelly, consisting of two plates joined by a median suture, the exterior face smooth or striated and the interior marked by growth-lines. Prof. Waagen has recently adopted the theory first advanced by Keferstein, and afterwards supported by Zittel, that the aptychi were connected with the nidimental gland, and he has even proposed a classification of Ammonitidæ based upon the absence or presence, and peculiarities when present of these bodies.

If, as Férussac first suspected, the Ammonite was a dibranchiate cephalopod, with the shell like that of the Spirula more or less completely covered by the posterior portion of its body, instead of being a tetrabranchiate with external shell like the Nautilus, then the difficulty of accounting for the presence of the aptychus is increased, if that body is truly a product of the nidimental gland; moreover, the outer layer of the shell estimated as epidermal in character, must be otherwise explained. It is difficult to imagine a shell internal, that is provided with the spinous processes of some of the species, and hard to reconcile the weight and size of sundry "cart-wheel" Ammonites with the idea of an internal shell. Fischer, however, appears disposed to take this view of the subject, following Hyatt and other recent investigators. For myself, I prefer leaving Ammonites among the tetrabranchiates, and, consequently, considering its shell as external, and that the aptychus is essentially an operculum, or a product of the "hood" which exists in Nautilus, and may have similarly existed in Ammonites.

Von Jhering finds in the aptychus a possible product of the cartilaginous neck-button of dibranchiate decapod Cephalopoda —that is, supposes them to be a product of a similar organ; and upon this theory he would consider them dibranchiates instead of tetrabranchiates. The use of the neck-button is not so apparent in an animal having a heavy external shell for its protection, and if the shell be considered internal, as in Spirula, and the animal also similar, it would be difficult to imagine how the aptychi occur in the body-chamber.

The outer layer of the shell has been generally destroyed in

fossil Ammonites, etc., leaving only the inner or nacreous and more indestructible layer, which thus exhibits perfectly the edges of the septa; but in some cases it is only the outer layer that has been preserved; and frequently when the whole shell has disappeared, we have perfect *casts* of the chambers. The decomposition of the animal has contributed to form those phosphates and sulphides generally present in the body-chamber, whilst the permeation of water deposits crystals of calcareous spar on the inner walls or sometimes even fills the entire chamber. Cross-sections of fossil Ammonites with the chambers filled with spar, when polished, make beautiful cabinet specimens. Sometimes, as in some of the Orthocerata, the circumjacent mud has invaded the air-chambers, but without entirely filling them, because the contraction of the vascular lining has left empty spaces between itself and a portion of the wall of each chamber.

Gastropoda are mostly provided with an external shell, a dwelling-place and a citadel combined, the hardness and durability of which, as Keferstein remarks, "supplies us with the best means of knowing the animal: indeed, in many cases, it is the only part known, and was formally the only part valued and preserved in collections. Although the animal itself offers more weighty and striking characters for the separation of the higher groups, yet having learned the close relationship existing between shell and animal, we find therein ample justification for attaching especial importance to the shell in a systematic point of view."

We have already shown how the shell is produced by the mantle.

The form of the shell is throughout regular, and is normally a cone curved into a spiral, and descending in a screw-like manner from the apex or initial whorl to the aperture (ii, 30). Nothing can be more beautiful than the regular geometrical progression of the growth of a shell or the certainty with which each species and genus grows in its normal pattern, although these modes vary among themselves so widely; thus we have the simple depressed cone of the Patella (lxxxiii, 25), all aperture and no spire, and from it every gradation, from the Haliotis (lxxxiii, 9), almost equally depressed and broad, the result, however, of a very rapidly enlarging spiral, to the long, many-whorled Turritella (lxvii, 59), or the Vermetus (lxvii, 68), which is a Turitella partially unrolled into a simple long tube;—the opposite of the Patella. The whorls of a spiral shell are, in most cases, closely wound around its axis, and, therefore, most part of their surface is in contact, each whorl partially covered and concealed by its successor; and where the axis does not lengthen by the obliquity of the spiral, we find, as in the cone (lviii, 42),

and Cypræa (lxi), that the shell only shows externally its last whorl, with, perhaps, a very small portion of its predecessors visible on the spire. On the other hand there are genera in which the whorls are not at all in contact, and where the axis becomes itself an imaginary cone, widest at the base. Besides the almost numberless modifications of form resulting from the degree of obliquity and closeness of the spiral, the direction of the latter may be mentioned as another factor in producing modification. In most spiral shells the spire normally curves to the right, that is to say, placing the shell with its apex turned from the observer and its aperture in view, the latter will be found on the right hand. In others the volutions proceed in the opposite direction with such regularity as to be eminently characteristic of some species and genera (Physa, Clausilia, etc.). However, in certain genera, it is found that species normally dextral will exceptionally produce sinistrally coiled shells, and *vice versa*, and this abnormal growth, probably is caused by disturbance of the relations of the embryo with its initial shell.

Whilst the bulk and weight of these shells are composed principally of carbonate of lime, yet they have always an organic basis, which is first developed, and then gradually impregnated with the lime. If the latter be removed by the use of acids the organic residuum (conchyolin) still retains the shape of the shell, forming a sort of membranous framework. It is this organic basis which maintains the life of the shell, for, the animal removed as in beach-worn or fossil species, the conchyolin soon disappears and the shell becomes pure carbonate of lime, growing at the same time more and more brittle.

There are, as before stated, three layers of deposition (of which the middle one is thickest in many cases), each composed of a multitude of plates or prisms, but each differing in the direction of arrangement of these. It will be readily perceived how much this diversity of arrangement adds to the toughness of the shell structure, as no line of fracture can penetrate the entire shell wall, except by the violent breaking across of part of these layers of prisms.

As to the chemical composition of shells, the conchyolin or organic material is a small, varying percentage, carbonate of lime, existing in quantities varying, from Turritella, 88·70 per cent. to *Strombus gigas*, 99 per cent. There are traces of other constituents, of which carbonate of magnesia is perhaps one of the most important; it varies from 0·12 per cent. in Telescopium to 0·48 per cent. in *Fusus antiquus*. Silicic acid has also been detected. C. Schmidt has obtained almost 1 per cent. of phosphate of lime from the shell of *Helix nemoralis*. The calcareous operculum of Turbo (analyzed by Wicke) contains: Carbonate of lime, 98·72 per cent.; organic material, 1·28 per cent. The

American oyster, according to Prof. Wm. B. Rogers, contains: Carbonate of lime, 95·18 per cent.; phosphate of lime, 1·88 per cent.; silex, ·40 per cent.; water, 1·62 per cent.; animal matter, ·45 per cent.

Shells are perceptibly harder than, and will scratch calc-spar. Their specific gravity is somewhat higher than that of Carrara marble, being about 2·75 to 2·85 for the prosobranchiates, and varying but slightly in the pulmonates.

With reference to the coloring of shells (terrestrial as well as marine species) Fischer points out that as a rule, brilliancy of coloring increases towards the equator. He suggests three zones of coloration corresponding to the thermal zones, which may be designated as:

1. Monochromic or frigid zone.
2. Oligochromic or temperate zone.
3. Polychromic or tropical zone.

Of course exceptions are numerous—modifications based upon habits, ocean currents, adaptive coloration, etc. M. Fischer particularly cites the melanism which characterizes so many shells of the West Coast of North and South America, giving, among other examples, the numerous species of sad-colored and lugubriously-named Trochi, which pervade those regions.*

On Protective Coloration. A number of papers on mimicry or adaptive resemblance as a means of protection of mollusks against their enemies have been published, and the subject has awakened much interest and discussion. Coincidence of coloration of molluscous animals with their surroundings has been frequently remarked, but it is probably not so often for purposes of attack or security as the result of the food upon which they live or a dye obtained by contact with it. Mr. Morse gives a number of instances of coincidence of color between American marine mollusks and their surroundings which he supposes to be evidences of protective adaptation† of these, three principal species of Crepidula or slipper-limpet, may be cited: *C. fornicata* is drab, variously rayed and mottled with brown, and it lives attached to stones or on the outside of shells of similar color; *C. convexa* has a dark brown shell, and is found on *Ilyanassa obsoleta* or on the roots of sea-weed; *C. plana* is white, and inhabits the *inside* of the aperture of dead shells, which is also white. Mr. Melvill mentions that *Ovulum uniplicatum*, as it is found on the Florida coast, is yellow or purple according to the color of the gorgonia on which it occurs.

"The thickness, the roughness, and the smoothness of the surface of shells appear to depend, in a great measure, on the

* Dr. P. Fischer, *Jour. de Conch.*, xxiii. 105, 1875.

† E. S. Morse, *Proc. Bost. Soc. Nat. Hist.*, xiv, 141, 1871.

stillness or agitated state of the water in which they reside. Shells which have branching or expanded varices, like the Murices, are also much influenced by circumstances, and hence many mere varieties, arising from local causes, have been considered as distinct species. Thus *Murex angüliferus* is merely a *Murex ramosus* with simple varices; and *Murex erinaceus*, *M. torosus*, *M. subcarinatus*, *M. cinguliferus*, *M. Tarentinus*, and *M. polygonus* are all varieties of one species. *Murex Magellanicus*, when found in smooth water, is covered with large acute foliaceous expansions; but the same shell living in rough seas is without any such expansions, and only cancellately ribbed. In such situations it seldom grows to a large size; but when it does so, it becomes very solid, and loses almost all appearance of cancellation. *Triton maculosus* is very widely spread over the ocean in different temperatures and different kinds of seas; it consequently offers a multitude of varieties both of size and surface, all gradually passing into each other, and most probably produced by the operation of the foregoing causes. Indeed, a vast number of merely nominal species have been formed from the habit, too prevalent among conchologists, of describing from single specimens, or even from several individuals brought from the same locality, which would never have been considered as distinct had collectors kept in their cabinets a series of specimens found under different circumstances, and studied on the coasts where they are found, the variations which shells undergo."—Dr. J. E. Gray, *Philos. Trans.*, 771, 1833.

I have inserted the above as a sort of warning to species-makers and because my own experience partially confirms it; but Dr. Gray was too apt to propose theories in explanation of difficulties and to find illustrations and confirmations of such theories in hasty assumptions rather than by the careful observation of facts.

Rest-periods in the growth of mollusks are sometimes, as in the Murices, marked by a thickening of the edge of the shell, caused by continuous depositions of shell-material, forming a ridge or varix; and the rate of growth may be thus traced readily, in numerous mollusks. Thus in Murex one group shows three varices upon each whorl (xliii, 5), indicating that a period of three years, or at least three seasons of activity is required for the completion of a single whorl of growth. In another group of Murices the varices are more numerous (xliii, 7), as many as four to ten being counted on a whorl. In Triton, the varices are two on each whorl, but nearly alternately situated (xlvi, 54) so that the varices of each whorl occupy an intermediate position to those on the preceding whorl; in Ranella there are also two varices but they form a continuous fringe or wing-

like expansion on each side of the spire (xlvi, 69), showing a very regular growth by periods of half-whorls.

The accretion of surface during growth is not continuous but is made by minute layers, around the margin of the aperture, each extending a little beyond its predecessor, and the edges of these layers as exposed on the external surface are called growth-lines. Those shells which have a simple, or sharp-lipped aperture and which do not develop varices, nevertheless distinctly show the rest-periods by the greater impression of the growth-lines. Many shells retain the sharp aperture for a variable period, which may be called their juvenescence, but finally acquire adult characters, consisting of a thickened, reflected, inflected or lipped aperture—which is sometimes more or less contracted by inflected calcareous projections called teeth. Growth, however, frequently continues after adult characters have been acquired, and then these are usually absorbed away when accretion recommences, leaving the mark of their former position in a more prominent growth-scar or line.

The power of dissolving their shells is possessed by certainly a large portion of the mollusca; thus the cone, which we have seen partitioning off its whorls against an enemy and thus seriously incommoding itself for room, would under normal circumstances acquire for itself additional accommodation by absorbing away most of the thickness of the enclosed whorls or partitions, and Cypræa, Nerita and Auricula (i, 14), assist themselves in the same manner so as to become eventually an external shell only, with a single cavity. In species with lengthened spire, this method is not so practicable, because only a small portion of the worls are enclosed within succeeding ones.

From what has been said of the mode of formation of shells it will be readily seen that details of sculpture as striæ, sulcations, ribs, nodes, spines, etc., result from similar ornamentation of the applied mantle; thus the spine of a Murex, if closely examined, will be found to have a longitudinal seam upon its front face, showing that it has been formed by a corresponding digitation of the mantle. It is scarcely necessary to pursue this subject further at this time; reference to the plates will demonstrate this relationship of shell and animal.

The following are the principal modifications of form in the gastropod shell.

A. Regularly spiral.

- *a.* Elongated, subulate, elevated. Terebra (lvii, 11).
- *b.* Turrited, turriculated, babylonic; an elongated shell with the whorls angulated or shouldered on their upper part. Turritella (lxvii, 56).
- *c.* Cylindrical, pupiform. Cylindrella, Pupa (i, 12).

d. Short, bucciniform. Buccinum (l, 27).
e. Fusiform, spindle-shaped. Fusus (xlvii, 70).
f. Contabulate, short, with shouldered whorls (xlvii, 82).
g. Globular. Natica (lxiii, 44).
h. Gibbous. Whorls swelled beyond the normal contour of increase (usually on the aperture side). Streptaxis.
i. Depressed, lenticular. Rotella (lxxix, 95).
j. Discoidal. Daronia (lxxix, 90).
k. Convolute; aperture as long as the shell, nearly or quite concealing the spire. Cypræa (lxi, 96).
l. Trochiform, pyramidal, conical with a flat base. Trochus (lxxx, 39).
m. Turbinated; conical, with rounded base. Turbo (lxxx, 29).
n. Cone-shaped, obconic. Conus (lviii, 42).
o. Few-whorled. Helix haemastoma.
p. Many-whorled. Helix polygyrata.
q. Ear-shaped. Haliotis (lxiii, 10).

B. Scalariform, whorls not impinging. Scalaria (lxvi, 42).
C. Irregularly spiral, evolute. Siliquaria (lxvii, 79). Vermetus (lxvii, 68).
D. Tubular. Dentalium, or tooth-shell.
E. Shield-shaped. Umbrella (lxxxix, 89).
F. Boat-shaped, slipper-shaped. Navicella (lxxviii, 76). Crepidula, (lxv, 92).
G. Conical or limpet-shaped. Patella (lxxxiii, 26).
H. Multivalve and imbricated. Chiton (lxxxvi, 85).

The only *symmetrical* shells are those of Carinaria, Atlanta, Dentalium and the limpets.

The cavity of the shell is a single conical or spiral chamber; no gastropod has a multilocular shell like the Nautilus, but particular species, as we have seen, form spurious chambers by partitioning off the whorls; many form such partitions as a protection against the attacks of boring animals, or when the upper part of the spire is destroyed. Some spiral shells are complete tubes with the whorls separate or merely in contact, as Scalaria; but more commonly the inner side of the spiral is formed more or less by the previous whorls.

The axis of the shell, around which the whorls are coiled, is sometimes open or hollow; in which case the shell is said to be perforated, or *umbilicated*, *e. g.* Solarium (lxvi, 34). The perforation may be a mere chink, or fissure (*rima*), as in Lacuna (lxix, 82); or it may be filled up by a shelly deposit, as in many Naticas (lxiii, 45). In other shells, like the Triton, the whorls are closely coiled, leaving only a pillar of shell, or *columella*, in the centre: such shells are said to be *imperforate*. The name

columella, however, is usually applied to that portion of the inner wall of the shell which invests the axis—whether it be solid or open: it therefore is the lower portion of the inner margin of the aperture in most spiral shells. It is wanting in discoidal shells (Planorbis), hidden or minute in convolute shells (Bulla and Cypræa) and in ear-shaped shells (Haliotis). Non-spiral shells have no columella.

The *apex* or posterior end of the shell presents important characters, as it was the *nucleus* or part formed in the egg; it is sinistral in the Pyramidellidæ, oblique and spiral in the Nucleobranchs and Emarginulæ, and mammillated in *Turbinella pyrum* and *Fusus antiquus*.

The apex is directed backwards in all except some of the Patellidæ, in which it is turned forwards, over the animal's head. In the adult condition of some shells the apex is always truncated (or *decollated*) as in Cylindrella and *Bulimus decollatus;* in others it is only truncated when the animals have lived in acidulous waters (*e. g.* Cerithidea and Pirena), and specimens may be obtained from more favorable situations with the points perfect.

A *whorl* measures a single complete revolution of the spiral cone; its *periphery* is an imaginary spiral upon the outer wall, half-way between the suture and base: line of greatest width. In counting the number of whorls in a shell commence with the aperture-margin, whence, to a point on the suture of the volution above it constitutes one whorl; repeat this process to the apex.

The line of channel formed by the junction of the whorls is termed the *suture*.

The last turn of the shell ending with the aperture (*body-whorl*), is usually very capacious; the others are collectively called *spire-whorls*. In the females of some species the whorls enlarge more rapidly than in the males (e. g. *Buccinum undatum*). The *base* or anterior extremity of the shell is the opposite end to the apex, and is usually the front of the aperture.

The distance between the apex and base of a gastropod shell is termed its *height*. It has usually been called *length*, but the other designation corresponds better with the terminology of the lamellibranchiates as well as the non-spiral gastropods: thus in Patella, the distance from summit to base is *height*, from anterior to posterior margin is *length*, from side to side is *breadth*. In spiral shells the *breadth* or *diameter* is the distance across the body-whorl at its periphery.

The aperture is *entire* in most of the vegetable feeders (holostomata), but notched or produced into a *canal*, in the carnivorous families (siphonostomata); this canal surrounds a siphon, which is respiratory in its office, and does not necessarily indicate the nature of the food. Sometimes there is a posterior channel or canal, which is excurrent, or anal, in its function (*e. g.* Strombidæ

and *Ovulum volva*); it is represented by the slit in Scissurella, the tube of Typhis, the perforation in Fissurella, and the series of holes in Haliotis.

The margin of the aperture is termed the *peristome* (less frequently *peritreme*); sometimes it is continuous or entire (Cyclostoma), or becomes continuous in the adult (Carocolla); very frequently it is interrupted, the left side of the aperture being formed only by the body-whorl. The right side of the aperture is formed by the outer lip (*labrum*), the left side by the inner or columellar lip (*labium*), or partly by the body-whorl [termed the "wall of the aperture" (*parietal wall*), by Pfeiffer].

The aperture is descending, deflected, when it does not follow the spiral of the shell, but turns downwards. This occurs in many shells, Helix, etc.

Sometimes it departs from contact with the preceding whorl, as frequently in Cylindrella.

The aperture is :—

Longitudinal, when its greatest diameter is parallel with the axis of volution.

Transverse, reverse of longitudinal.

Oblique, greatest diameter oblique to the axis.

Circular, rotundate, orbicular.

Rounded, the circle slightly interrupted.

Auriform, ear-shaped, as in Auricula.

Ovate, egg-shaped.

Oblong, much longer than wide, rounded above and below.

Lunate, semilunar, semicircular. Nerita.

Triangular. Janthina.

Linear, narrow. Cypræa, Conus.

Quadrate. Solarium.

It is *patulous* when dilated and *compressed* when diminished at its entrance.

The outer lip is usually thin and sharp in immature shells, and in some adults (*e. g.* Helicella and Bulimulus); but more frequently it is thickened, or *reflected;* or curled inwards (*inflected*), as in Cypræa; or expanded, as in Strombus; or digitate, as in *Pterocerus;* or fringed with spines (*foliated*), as in Murex. The lip is *emarginate*, when incised or slit, as in Pleurotomaria (lxxxii, 84); *effuse*, when the basal or anterior extremity is slightly produced, depressed or reflected, as in Melania; *sinuous*, as in the sigmoidal margin in Janthina. Interiorly it may be *dentate*, Nerita (lxxviii, 56); *plicate* or *lamellate*, when the teeth become rib-like; *ringent*, having numerous large plications, nodules or teeth, Scarabus; *sulcate*, when grooved within; and *labiate* or *marginate*, when callously thickened near the margin.

Sculpture or color-markings upon the shell are *longitudinal*

when taking the direction of the axis, and *revolving* (or less properly *transverse*) when they follow the spiral. In the latter case they are also sometimes spoken of as *longitudinal*, with reference to the whorls only and not to the entire shell; but to avoid confusion it is becoming usual to consider their direction with reference to the shell.

The following are the principal varieties of sculpture:—

Canaliculate, suture profoundly channeled.

Cingulate, encircled by revolving ribs.

Carinate, revolving sculpture prominent, sharp.

Sulcate, encircled by channels.

Plicate, costate, ribbed, sculpture longitudinal.

Nodosely, tuberculately, granosely plicate, when the ribs are broken up into tubercles or granules; mostly caused by the intersection of revolving sculpture.

Striate, covered by fine close lines, either longitudinal or revolving.

Punctate, pitted.

Frequently punctate-striate are combined, as in Mitra.

Granulate, nodose, tuberculate, covered with nodules of small or large size, but not ribbed.

Muricate, spinous, echinate, when the nodules are sharp-pointed.

Decussate, cancellate, longitudinal and revolving sculpture crossing at right-angles.

Reticulate, sculpture not crossing at right-angles; irregularly decussated.

Clathrate, longitudinal and revolving lines both distant, forming a pattern somewhat like the iron bars of a prison window.

The last two terms are often used improperly as synonymous with decussate or cancellate.

Coronate, the upper part of the whorls having a series of revolving tubercles or spines.

Varicose, when the external thickening of the margin of the aperture occurring in some shells during rest-periods, is not absorbed away when growth is resumed, but remains, crossing the whorls at regular intervals.

THE OPERCULUM.

This is present in most gastropod mollusca, particularly in those provided with spiral shells; it also occurs in the larval stage of many nudibranchiate and opisthobranchiate mollusks, which are then provided with a temporary shell. The pulmoniferous land and fresh-water gastropods are inoperculate.

At the ending of the columellar muscle in the dorsum of the

foot, its fibres are nearly vertical to the plane of the operculum, which usually appears to be immediately superimposed upon them: in Buccinum, however, Keferstein finds interposed a layer of long cylindrical epithelial cells, with mostly distinct nuclei, and long divided processes entering between the muscular fibres.

The operculum, a cuticular development of these cells, is composed, as may be seen in the corneous opercula of Murex, Purpura, Triton, etc., of very thin superimposed layers. With the microscope one may perceive in a thin section, the cylindrical cells with their head attached to the lowermost layer; or, on the inner face, the small rounded pittings where they have been attached.

Homologies of the Operculum. Dr. J. E. Gray was, after Adanson, the first investigator who considered the operculum homologous with the right valve of the lamellibranchiates or bivalve mollusks. He has shown that the operculum is developed on the embryo long before it is hatched; that it is placed on and covers a particular part of the body called the *lobus operculigerus* and which bears to it the same relation which the mantle does to the shell, and that its growth occurs in the same manner; that this growth is made by the addition of new matter to the inner surface and especially near the margin; that it is attached to the animal by means of one or more muscles, which, as in the bivalve shell, pass from the larger valve or shell to the smaller one or operculum; that the operculum, as it increases in size, is gradually moved on the end of its muscle—the many-whorled operculum of the Trochi revolves as many times on the end of the muscle as the many-whorled spiral shell turns on its imaginary axis; that the operculum is often lined internally with a shelly coat like a shell, and sometimes, like the Cowries, its outer surface is covered also with a shelly deposit by a special development of the opercular lobe.

The principal difference between the operculum and the valve or shell of the gastropods consists:—

1. In the operculum having no cavity, its cone being depressed, flat or even concave, or very much compressed, forming only a spiral riband, as in the spiral operculum. But this absence of a cavity is a difference only of degree, for the valves of some gastropods, as Umbrella, Patella, etc., are much flattened; the first resembling the annular operculum of Ampullaria and Paludina; but the greatest resemblance is to be observed in the small, flat valves of Gryphæa, Exogyra, Chama, and other genera of bivalve shells which are attached by one of their valves. These valves are often quite as flat and destitute of any cavity as the operculum of any gastropod; and it is to be remarked that these valves exactly resemble a spiral operculum in shape, the remains of the ligament forming a spiral mark on the outer

surface, showing how the valve has rotated on the body of the animal as the operculum rotates on the foot of the gastropods.

2. The operculum is generally horny and formed of a substance similar to the epidermis of shells; but then some shells, like the Bulla, Aplysia, certain Uniones, etc., are entirely or almost destitute of calcareous matter, and some of the helices, when inhabiting granitic regions, are equally of epidermal substance: on the other hand many opercula are thickened internally with a calcareous deposit.

Dr. Gray proceeds to show that in bivalve shells like Chama, where one valve (the attached one) has a spiral apex, whilst the other valve is a flattened spire, the position of the hinge with reference to the spire must rotate slowly with growth, as in the spiral operculum in its growth. The direction of the spire of a spiral operculum is opposite that of the shell, showing another analogy.

The conclusion arrived at by Dr. Gray is that the normal or typical form of mollusks is that protected by two valves or shells.

Dr. Gray has always maintained that the opercula are of great value in the distinction of genera, and he does not fail to condemn severely the practice of preserving shells in museums, or of figuring and describing them in conchological works, without opercula. I have already alluded to the supposed opercular bodies found with the fossil Ammonites: it may be added that they occur as well in some of the Heteropods and Pteropods.

In 1847, Lovén proposed to consider the operculum as analogous to the byssus; but Dr. Gray has pointed out that some genera of gastropods provided with an operculum, secrete a byssus also (Rissoa, Cerrithium, Littorina, etc.). However, Prof. Huxley, one of the latest and best authorities, thus endorses Lovén's views, which are now generally adopted:

"On the hæmal aspect of the posterior portion of the foot, a chitinous or shelly plate, termed the operculum, may be developed. This operculum appears to be the analogue, if not the homologue, of the byssus of the lamellibranchs; and is certainly not homologous with either of the valves of the shell of the latter, which are pallial structures."—HUXLEY, *Anat. of Invert.*, 487, 1877.

The following note by Dr. Gray, will throw some light on this very interesting subject:

"*On the reproduction of the lost part of an operculum, and its probable restoration when entirely destroyed.*

"It is to be expected that the operculum of a gastropodous mollusk may be sometimes broken or injured, but I have never hitherto been able to find any very distinct example of the kind, so as to study how the repair of the lost part would be effected.

That such an occurrence would most probably be rare, is easily explained from its situation, as the operculum is protected by the last whorl of the spire of the shell when the animal is expanded, and by the mouth when it is contracted into the cavity of the shell.

"I have lately met with a very distinct example in a specimen of Fusus in the British Museum collection. In this specimen the apical half of the operculum has been broken off and the lost part has been renewed by an irregular roundish process, nearly of the size of the lost part, not quite as thick as the original portion, and formed of rather irregular horny plates; the smaller or first-formed portion being in the centre of the broken line, so that the restored part bears some similarity to the annular operculum of a Paludina. This restoration is exactly like that which would have taken place in a shell under similar circumstances, and is a further proof of the truth of the theory which I have long advocated, that the operculum is a rudimentary valve, and is homologous to the second valve of the bivalve mollusks.

"In examining two specimens of *Pleurotoma babylonica*, preserved in spirits, with the opercula attached, I was much surprised to observe that the opercula of the two specimens were exceedingly different in structure and belonged to two distinct modifications of that valve, one being subannular, with the nucleus apical, like the other species of the genus, and the other annular, with the nucleus subcentral, somewhat like the operculum of Paludina. The examination of the restoration of the lost half of the operculum of the Fusus before referred to has solved the difficulty, and I have no doubt that one of these animals had by some accident lost its operculum, and that it had gradually restored it; commencing, as in the case of the restored part of the operculum of the Fusus, by a small nucleus in the centre of the opercular mantle, on the back of the foot, and gradually adding new layers around the edge of it, until it formed an annular operculum nearly of the size of the original, but differing from it in shape, being less acute in front and nearly similar in form at the two ends. A more minute examination has strengthened this theory, for the operculum of this specimen is less regularly developed than is usual in the annular operculum of the kind, and is much thinner than the normal operculum of the genus, as is the case in both these particulars with the restored part of the operculum of the Fusus.

"This change in the formation of the operculum when it is reproduced is just what might have been expected. The animal, when it has to form the operculum at its birth, begins its formation at the tip, and increases its size, as the animal requires a larger operculum for its protection, by the addition of new

layers to the outer edge of its larger and last-formed end; but when it has to reproduce this organ, the opercular mantle having reached a certain size, it proceeds to cover its surface with a new protection in the most easy and rapid manner, and, commencing from a more or less central spot on the surface, enlarges the surface covered by adding new matter to the entire circumference of the first-formed part; it continues this process without waiting to make the operculum as thick and solid as the one which was lost, until it reaches the size of the original, moulding itself on the opercular mantle, and adapting its form to the form of the throat of the aperture of the shell which it has to close. The change of form in the front of the restored and mended operculum is caused by the parts being moulded on the existing opercular mantle—consequently they have not the narrow front part which is found in the normal form caused by that part having been formed when the animal had this part of a small size; and as it increases in size the whole opercular mantle moves forward, leaving the small tip of the operculum free, and useless to the animal, and, therefore, not necessary to be reproduced when the operculum is re-formed in the adult age of the animal."

The *operculum* presents modifications of structure which are so characteristic of the subgenera as to be worthy of particular notice. It consists of a horny layer, sometimes strengthened by the addition of calcareous matter on its exterior. Its inner surface is marked by a muscular scar, whose lines bear no relation to the external lines of growth, and its form is unlike the muscular scar in the shell. It is developed in the embryo, within the egg, and the point from which it commences is termed the nucleus; many of the spiral and concentric forms fit the aperture of the shell with accuracy, the others only close the entrance partially, and in many genera, especially those with large apertures (*e. g.* Dolium, Cassidaria, Harpa, Navicella), it is quite rudimentary or obsolete.

The operculum is described as—

Concentric, when it increases equally all round, and the nucleus is central or subcentral, as in Paludina and Ampullaria (lxxiv, 16).

Imbricated, or lamellar (ii, 35), when it grows only on one side, and the nucleus is marginal, as in Purpura, Phorus, and Paludomus.

Claw-shaped, or unguiculate (ii, 34), with the nucleus apical or in front, as in Turbinella and Fusus; it is claw-shaped and serrated in Strombus (iii, 49).

Spiral, when it grows only on one edge, and revolves as it grows; it is always sinistral in dextral shells.

Paucispiral, or few-whorled (ii, 37), as in Littorina.

Subspiral, or scarcely spiral, in *Melania* (lxxi, 15).

Multispiral, or many-whorled (ii, 36), as in *Trochus*, where they sometimes amount to twenty; the number of turns which the operculum makes is *not* determined by the number of whorls in the shell, but by the curvature of the opening, and the necessity that the operculum should revolve fast enough to fit it constantly. (Moseley).

Articulated, when it has a projection, as in Nerita (ii, 38).

Radiated is a modification of the articulated operculum in which the spiral is not so evident. Navicella(lxxviii,78).

Too much importance, however, must not be attached to this very variable plate, as an aid to classification; it is present in some species of Voluta, Oliva, Conus, Mitra, and Cancellaria, but absent in others; it is (indifferently) horny or shelly in the different species of Ampullaria and Natica; in Paludina, it is concentric, whilst in the nearly related Paludomus it is lamellar, and in Cerithium it is either multispiral or paucispiral. The epiphragm or temporary plate with which pulmoniferous land snails close the aperture of the shell during hibernation may be distinguished from the true operculum by its homogeneity and want of growth-marks.

The operculum is large and well developed in *Concholepas Peruvianus*, a large species of Purpuridæ having a shell limpet- or rather haliotus-like in its greatly expanded aperture and body-whorl and comparatively small spire. The animal, like the limpets adheres firmly by the suction of its foot to rocks, so that an operculum is in this case an entirely useless appendage—yet it is always present.

"The majority of the individuals of *Volutharpa ampullacea* are without opercula, even without a trace of the pad-like gland or area from which the operculum is secreted. About ten per cent. of the individuals of the var. *acuminata* which I have examined had traces of this gland or area, marked by its smooth and rather whitish surface on the granulous dark slate-colored foot. About fifteen per cent. had well-developed opercula in the proper position. I have ascertained the same to be the case with regard to the typical form, from alcoholic specimens, collected by Dr. William Stimpson in Behring's Strait. There is no mistake about this, strange as it may and must appear, that different individuals of the same species are indifferently operculate or inoperculate.

A careful examination of this appendage reveals some singularities in it worthy of note. At first the operculum is of an ovoid form, with the nucleus near the edge at the larger end, and increases by additions around the edge, but principally upon the smaller or upper end. However, at some late period of its growth it takes a new start, and, seemingly, a new operculum

is commenced underneath the old one, with a central nucleus which increases by annular additions, and finally has its edges very much thickened and turned upward, giving it a saucer-like appearance, while the old operculum seems as if laying upon the saucer, with its nucleus and some of the adjacent portion projecting over the edge anteriorly. It has in all a diameter of ·1 inch. That its form is not due to an individual abnormality is evident from the fact that all the specimens examined were similar."—W. H. DALL, Am. Jour. Conch., vii, 106.

Mr. Gwyn Jeffreys, in his excellent "British Conchology," records the occurrence, upon the Kentish and Sussex Coasts, of *Buccinum undatum*, having two or three opercula. "In a bioperculate specimen, procured by Mr. Rich, one of the opercula is conical and borne on a cylindrical, stalk-like lobe, the other being of the usual shape; in a second specimen, one operculum is longitudinally oval, with the nucleus nearly terminal (as in Fusus), the fellow operculum being placed at a right-angle to it."

The duplication of opercula in *Buccinum undatum* appears to be paralleled by that of the internal horny pens or shells sometimes occurring in the cephalopod genus Loligo.

"The above facts," says Dr. Paul Fischer, "modify considerably our confidence in specific and generic characters furnished by the operculum. They at least demonstrate that the absence of an operculum will not suffice for the exclusion of mollusks from families the other genera of which are provided with them." *Jour. de Conch.*, 114, 1875.

The Pelecypoda, or lamellibranchiata differ widely from the two preceding great classes of mollusca in their shells. These are always present, and always external, and always bivalve (with sometimes small accessory pieces upon the hinge, as in Pholas). The two great classes of the encephala on the contrary are sometimes entirely without a testaceous envelope, and sometimes they possess it internally only; but in most cases it is present, external, and is usually univalve (in Chiton composed of eight plates). Bivalve mollusca are all aquatic, and except a very few genera, marine. In genera and species they are much less numerous than the gastropoda, the proportion being about one-third, but in individuals they are relatively much more numerous.

In their native element the Oyster and Scallop lie on one side, and the lower valve is deeper and more capacious than the upper. Most other bivalves live in an erect position, resting on the edges of their shells, which are of equal size. Those which move about much, like the river-mussel, maintain themselves nearly horizontally, and their keel-shaped foot is adapted for ploughing through sand or mud.

The burrowing species have a strong and stout foot with which they bore vertically into the sea-bed, often to a depth far

exceeding the length of their valves; these never voluntarily quit their abodes, and often become buried and fossilized in them. They most usually burrow in soft ground, but also in coarse gravel, and firm sands and clays; one small Modiola makes its holes in the cellulose tunic of Ascidians, and another in floating blubber.

The boring shell-fish have been distinguished from the mere burrowers, perhaps without sufficient reason, for they are found in substances of every degree of hardness, from soft mud to compact limestone, and the method employed is probably the same.

The means by which bivalves perforate stone and timber has been the subject of much inquiry, both on account of its physiological interest, and the desire to obtain some remedy for the injuries done to ships, and piers, and breakwaters. The ship-worm (Teredo) and some allied genera, perforate timber only; whilst the Pholas bores into a variety of materials, such as chalk, shale, clay, soft sandstone and sandy marl, and decomposing gneiss; it has also been found boring in the peat of submarine forests, in wax and in amber. It is obvious that these substances can only be perforated alike by mechanical means; either by the foot or by the valves, or both together, as in the burrowing shell-fish. The Pholas shell is rough, like a file, and sufficiently hard to abrade limestone; and the animal is able to turn from side to side, or even quite around in its cell, the interior of which is often annulated with furrows made by the spines on the front of the valves. The foot of the Pholas is very large, filling the great anterior opening of the valves; that of the ship-worm is smaller, but surrounded with a thick collar, formed by the edges of the mantle, and both are armed with a strong epithelium. The foot appears to be a more efficient instrument than the shell in one respect, inasmuch as its surface may be renewed as fast as it is worn away.

In the museum of the Academy of Natural Sciences of Philadelphia are specimens of *Pholas dactylus* from the coast of France imbedded in gneiss rock, much too hard to have been excavated by the valves of the shell; moreover the rough points of its sculpture show no signs of abrasion, which must surely have taken place if these delicate projections had been used to rasp the surrounding surface.

The mechanical explanation becomes difficult in the case of another set of shells, Lithodomus, Gastrochæna, Saxicava, and Ungulina, which bore into calcareous rocks, and attack the hardest marble, and still harder shells. In these instances the valves can render no assistance, as they are smooth, and covered with epidermis; neither does the foot help, being small and finger-like, and not applied to the end of the burrow. Their

power of movement also is extremely limited, their cells not being cylindrical, whilst one of them, Saxicava, is fixed in its crypt by a byssus. These shell-fish have been supposed to dissolve the rock by chemical means (Deshayes), or else to wear it away with the thickened anterior margins of the mantle (Hancock), or by the incessant action of the ciliæ of the mantle margin (Agassiz). All attempts to prove the use of an acid secretion in excavating have hitherto failed, as might be expected; for the hypothesis of an acid solvent supposes only a very feeble but continuous action, such as in nature always works out the greatest results in the end.

The holes of the Lithodomi often serve to shelter other animals after the death of the rightful owners; species of Modiola, Arca, Venerupis, and Coralliophaga, both recent and fossil, have been found in such situations, and mistaken for the real miners.

The boring bivalves have been called "stone-eaters" (*lithophagi*), and "wood-eaters" (*xylophagi*), and some of them at least are obliged to swallow the material produced by their operations, although they may derive no sustenance from it. The ship-worm is often filled with pulpy, impalpable sawdust, of the color of the timber in which it worked (Hancock). No shell-fish deepens or enlarges its burrow after attaining the full growth usual to its species.

Between the bivalve mollusks having *attached* valves, as in the oyster, and those which are *free*, as in Cardium, Lucina, Tellina, the fresh-water mussel, etc., are placed not only those in which the liberty of the animal is circumscribed by its living in a burrow, self-immured for life in a cell; but also those which spin a *byssus* (iii, 40), by which the shell is attached to some foreign substance, from which the individuals of the species usually depend in clusters or colonies. Usually byssus-spinners, as the Modiolas, Mytilus, or sea-mussel, are inhabitants of shore lines, in situations where, at low tide they are exposed above the waters; they are thus subject to the wash and lifting power of the incoming waves, and but for their anchor-like fastenings would be torn away from their haunts, dispersed, and frequently destroyed—as most free shells are in similar situations.

The *valves* of the Conchifera are bound together by an elastic *ligament* (ii, 31), and usually articulated by a *hinge* furnished with interlocking teeth (*ibid.*). The shell is closed by powerful adductor muscles (*ibid.*), but opens spontaneously by the action of the ligament, when the animal relaxes, and after it is dead.

Each valve is a hollow cone, with the apex turned more or less to one side; the apex is the point from which the growth of the valve commences, and is termed the *beak*, or *umbo* (*ibid.*). The beaks (*umbones*) are near the hinge, because that side grows least

rapidly; sometimes they are quite marginal; but they always tend to become wider apart with age. The beaks are either straight, as in Pecten; curved, as in Venus; or spiral, as in Isocardia and Diceras. In the latter case each valve is like a spiral univalve, especially those with a large aperture and small spire, such as Concholepas; it is the left valve which resembles the ordinary univalve, the right valve being a left-handed spiral like the reversed gastropods. When one valve is spiral and the other flat, as in Chama, the resemblance to an operculated spiral univalve becomes very striking.

In order to properly understand the relation of the bivalve shell to its owner, and thus obtain a clearer idea of the nomenclature employed in measurements, we should suppose a living lamellibranchiate to be creeping upon the sea-bed, its line of march directed from us. The shell will then be elevated, the ligament or hinge-margin uppermost, the opposite margin whence the foot protrudes lowest; these are then termed the dorsal and ventral margins respectively, and the distance between them is the height of the shell. I use dorsal margin in preference to beaks as a point of measurement, because in some mollusks, such as Mytilus, the beaks are at the anterior end; it is difficult to so locate the measurements as to suit all forms of shells. The hinge-line then indicates the direction of the length of the shell, and the actual length is the distance between the anterior and the posterior (or collectively lateral) margins. The breadth is a diameter transverse to the length, and includes the distance between the greatest exterior convexity of each valve. The thickness refers to the distance included between the internal and the external face of a valve. When the animal travels from us in this manner, hinge-line uppermost, the beaks are usually nearer to, and their apices directed forwards towards the anterior end, or the direction of march; whilst the ligament binding the valves together is posterior to the beaks, or nearest the observer. The valves lying on the right and left sides of the hinge-margin, when the shell is thus placed, are respectively termed right valve and left valve.

As the shell lays before us in the study, the valves may be thus distinguished; place the dorsal margin from you, the ventral margin towards you, the exterior surface exposed; if the ligament is on the left side, you have the right valve, and if on the right side, the left valve. There is frequently a *lunule* (ii, 31), or small semicircular impression anterior to the beaks; when this appears on the right side, the valve is right, and *vice versa*. If the interior of the valve is placed uppermost, the dorsal margin from us, the ventral margin towards us, we look first for a sinus or flexure (ii, 31) of the pallial impression, a mark made by the retractor of the siphons; if on the left side, the

valve is left, and *vice versa*. Sometimes also there are posterior lateral teeth or laminæ of the hinge-margin which are found on the right or left side, according as the valve is right or left. When these distinguishing marks of the interior are absent, the valves can be more readily determined externally.

In monomyary and attached shells it is sometimes difficult to distinguish the valves. The single muscular scar is on the posterior side of the interior, and in Pecten, the *byssal sinus* is below the *ear* on the anterior side (ii, 32).

Linnæus and the naturalists of his school described the front of the shell as the back, the left valve as the right, and *vice versa*. In those works which have been compiled from "original descriptions" (instead of specimens) sometimes one end, sometimes the other, is called *anterior*; and the *length* of the shell is sometimes estimated in the direction of the length of the animal, but just as frequently in a line at right-angles to it.

The conchifera are mostly equivalve, the right and left valves being of the same size and shape, except in the Ostreidæ and a few others. In Ostrea, Pandora, and Lyonsia, the right valve is smallest; in Chamostrea and Corbula, the left; whilst the Chamaceæ follow no rule in this respect.

The bivalves are all more or less *inequilateral*, the anterior being usually much shorter than the posterior side. Pectunculus is nearly equilateral, and in Glycimeris and Solemya the anterior is much longer than the posterior side. The ligament is sometimes between the umbones, but is never anterior to them.

Bivalves are said to be close, when the valves fit accurately, and gaping, when they cannot be completely shut. In Gastrochæna the opening is anterior, and serves for the passage of the foot; in Mya it is posterior and siphonal; in Solen and Glycimeris both ends are open. In Byssoarca there is a ventral opening formed by corresponding notches in the margin of the valves, which serves for the passage of the byssus; in Pecten, Avicula, and Anomia the byssal notch (or sinus) is confined to the right valve.

The surface of bivalve shells is often ornamented with ribs which *radiate* from the umbones to the margin, or with *concentric* ridges, which coincide with the lines of growth. Sometimes the sculpturing is oblique, or wavy; in *Tellina fabula* it is confined to the right valve. In many species of Pholas, Teredo, and Cardium, the surface is divided into two areas by a transverse furrow, or by a change in the direction of the ribs. The lunule (ii, 31), is an oval space in *front* of the beaks; it is deeply impressed in *Cardium retusum*, L., *Astarte excavata*, and the genus Opis. When a similar impression exists behind the beaks, it is termed the *escutcheon*.

The *ligament* of the Conchifera forms a substitute for the

muscles by which the valves of the Brachiopoda are opened. It consists of two parts, the ligament properly so-called, and the cartilage; they exist either combined or distinct, and sometimes one is developed and not the other. The external ligament is a horny substance, similar to the epidermis which clothes the valves; it is usually attached to ridges on the posterior hinge-margins, behind the umbones, and is consequently stretched by the closing of the valves. The ligament is large in the river-mussels, and small in the Mactras and Myas, which have a large internal cartilage; in Arca and Pectunculus the ligament is spread over a flat, lozenge-shaped area, situated between the umbones, and furrowed with cartilage grooves. In Chama and Isocardia the ligament splits in front, and forms a spiral round each umbo. The Pholades have no ligament, but the anterior adductor is shifted to such a position on the hinge-margin that it acts as a hinge-muscle.

The internal ligament, or *cartilage*, is lodged in furrows formed by the ligamental plates, or in pits along the hinge-line; in Mya and Nucula it is contained in a spoon-shaped process of one or both valves. It is composed of elastic fibres placed perpendicularly to the surfaces between which it is contained, and is slightly iridescent when broken; it is compressed by the closing of the valves, and tends forcibly to open them as soon as the pressure of the muscles is removed. The name Amphidesma (double ligament) was given to certain bivalves, on the supposition that the separation of the cartilage from the ligament was peculiar to them. The cartilage-pit of many of the Anatinidæ is furnished internally with a movable ossicle.

The ligament is frequently preserved in fossil shells, such as the great Cyprinas and Carditas of the London Clay, the Unios of the Wealden and even in some lower Silurian bivalves

All bivalves are clothed with an *epidermis* which is organically connected with the margin of the mantle. It is developed to a remarkable extent in Solemya and Glycimeris, and in Mya it is continued over the siphons and closed mantle-lobes, making the shell appear internal.

The interior of bivalves is inscribed with characters borrowed directly from the shell-fish, and affording a surer clue to its affinities than those which the exterior presents. The structure of the hinge characterizes both families and genera, whilst the condition of the respiratory and locomotive organs may be to some extent inferred from the muscular markings.

The margin of the shell on which the ligament and teeth are situated, is termed the *hinge-line* (ii, 31). It is very long and straight in Avicula and Arca, very short in Vulsella, and curved in most genera. The locomotive bivalves have generally the strongest hinges, but the most perfect examples are presented

by Arca and Spondylus. The central teeth, those immediately beneath the *umbo*, are called hinge (or *cardinal*) teeth (ii, 31); those on each side are *lateral* teeth (*ibid.*). Sometimes lateral teeth are developed, and not cardinal teeth (Kellia): more frequently the hinge-teeth alone are present (Alasmodon). In young shells the teeth are sharp and well defined; in aged specimens they are often thickened, or even obliterated by irregular growth (Hippopodium) or the encroachment of the hinge-line (Pectunculus). The dentition of bivalve shells may be stated thus:—cardinal teeth, 2·3 or $\frac{2}{3}$—meaning 2 in the *right* valve, 3 in the *left*; lateral teeth 1—1, 2—2, or 1 anterior and 1 posterior, in the *right* valve, 2 anterior and 2 posterior lateral teeth in the *left* valve. Many of the fixed and boring shells are *edentulous*.

The *muscular impressions* are those of the adductors, the foot and byssus, the siphons, and the mantle (ii, 30, 31).

Fossil bivalves are of constant occurrence in all sedimentary rocks; they are somewhat rare in the older formations, but increase steadily in number and variety through the secondary and tertiary strata, and attain a maximum of development in existing seas.

Some families, like the Cyprinidæ and Lucinidæ are more abundant fossil than recent; whilst many genera, and one whole family (the Hippuritidæ), have become extinct. The determination of the affinities of fossil bivalves is often exceedingly difficult, owing to the conditions under which they occur. Sometimes they are found in pairs, filled up with hard stone; and frequently as casts, or moulds of the interior, giving no trace of the hinge, and very obscure indications of the muscular markings. Casts of single valves are more instructive, as they afford impressions of the hinge.

Another difficulty arises from the frequent destruction of the nacreous or lamellar portion of the fossil bivalves, whilst the cellular layers remain. The Aviculidæ of the chalk have entirely lost their pearly interiors; the Spondyli, Chamas, and Radiolites are in the same condition, their inner layers are gone and no vacancy left, the whole interior being filled with chalk. As it is the inner layer alone which forms the hinge, and alone receives the impressions of the soft parts, the true characters of the shells could not be determined from such specimens. Our knowledge of the extinct Radiolite is derived from natural moulds of the interior, formed before the dissolution of the inner layer of shell, or from specimens in which this layer is replaced by spar.

The necessities of geologists have compelled them to pay very minute attention to the markings in the interior of shells, to their microscopic texture, and every other available source of comparison and distinction. It must not, however, be expected

that the entire structure and affinities of molluscous animals can be predicated from the examination of an internal mould or a morsel of shell, any more than that the form and habits of an extinct quadruped can be inferred from a solitary tooth or the fragment of a bone.*

"Who has not admired the beauty of shells?" exclaims Carpenter,† "the rich lustre of the Cowries; the glossy polish of the Olives; the brilliant painting of the Cones; the varied layers of the Cameos; the exquisite nacre of Mother-of-pearl? Who has not listened to the mysterious 'sound of the sea' in the Whelks and Helmets, or wondered at the many chambers of the Nautilus? What child ever went to the sea-shore without picking up shells; or what lady ever spurned them as ornaments of her parlor? Shells are at once the attraction of the untutored savage, the delight of the refined artist, the wonder of the philosophic zoologist, and the most valued treasures of the geologist. They adorn the sands of sea-girt isles and continents now; and they form the earliest 'footprints on the sands of time' in the history of our globe."

CARTILAGES.

Mollusks have no internal skeleton comparable to that of the Vertebrata, but in the Cephalopoda the most active and highly organized of the mollusca are found cartilaginous supports for some of the organs, partially replacing the vertebrate skeleton. Those of the principal nerve-ganglia are well developed, sometimes completely enveloping them; besides which the principal organs of sense, the valves of the mantle, the fins, etc., are duly provided.

As might be expected from its habits, the cartilaginous system of the Nautilus is the most simple of all the cephalopods, consisting of a well-developed head-cartilage, so shaped and situated as to support the œsophageal ring, the cerebral and pedal commissures, whilst two prolongations of it serve the funnel or siphon.

In the dibranchiata, unlike the Nautilus, the head-cartilage forms a complete ring around the œsophagus; from the medial line of the back of this ring spring two lancet-form cartilaginous processes, the cartilages of the eyelid, and the under side of the same ring spreads into a spoon-shaped process which comes far forward and supports the eyes; particularly when, as in Sepia, it reaches to the sides of the head and encompasses the ocular opening.

* *Études Critiques sur les Mollusques Fossiles, par L. Agassiz, Neuchatel*, 1840.

† *Lectures on Mollusca, Smithsonian Report*, 1860.

The cartilages of the back and of the fins are shown in position in Plate liii, 47, after Keferstein, of *Sepia officinalis*. In the Loligos the moon-shaped cartilage of the back is wanting, but is replaced in its functions by the upper end of the corneous pen or inner shell. In the octopods there remain only of this back-cartilage its two narrow posterior blade-like projections (*d*, same fig.). In the genus Cirroteuthis (iv, 58), the dorsal cartilage is very broad, so as to simulate the internal shell or pen of the decapod. At the entrance of the anterior ventral mantle opening is found a singular cartilaginous mechanism, which d'Orbigny has called the "appareil de résistance," peculiar to the Cephalopoda, which consists of buttons or ridges and corresponding grooves placed on the opposed inner sides of the mantle and the body, and by which the animal may at will button its head to the mantle to prevent the injury which might otherwise result to it during a struggle with wave or prey, in consequence of its want of support there (iv, 57). On the other hand, by relaxing this support the animal preserves for itself a freedom of movement of head and arms which would be impracticable were these as permanently and closely connected with the body on the ventral as they are on the dorsal side. The arrangement of this resisting apparatus varies in different genera, and is a good distinctive character: largely developed in those species which have no fixed attachment to the body, as in Ommastrephes, Loligo, etc., it exists also in those genera which possess only a very small cervical band of attachment, as in Argonauta, but it is wanting in those genera in which the permanent bands are well developed, as in Octopus, Cranchia, etc.

In Philonexis or Tremoctopus, a button is found at the base of the siphon tube, with a corresponding groove to receive it upon the inner wall of the mantle, but in Argonauta the relative position of button and buttonhole is reversed. In Rossia we find a short ridge surmounted by a profound groove opposed to an elongated groove on the base of the siphon; in Loligo and Sepioteuthis, the ridge is somewhat longer, without grooves; in Onychoteuthis and Enoploteuthis the ridge is nearly half the length of the body, with the siphonal groove; in Sepia an oblique oblong button can be fixed into a similarly formed pit upon the siphon; in Chiroteuthis there are an oblong longitudinal button and two lateral pits fitting into a central pit and two buttons on the siphon; finally, in Ommastrephes, in which it is most complicated, there are two projections, one oblong and the other triangular, entering cavities upon the siphonal tube, and two projections upon the latter which enter between the tubercles of the opposed mantle. The complexity of this attachment increases, it will be perceived, with the activity of the animal,

and in the comparatively sluggish littoral genera it is not found at all.

In the Gastropoda the cartilaginous internal supporting organs are reduced to two, or sometimes four small plates; they are found in the head, are more or less closely connected with one another, and are surrounded by the pharyngeal muscles. They form the supporting apparatus of the radula and the parts connected with it, and also afford points to which some of the pharyngeal and radular muscles are inserted (ix, 99).

MUSCLES, ARMS AND FINS IN THE CEPHALOPODA.

In Nautilus we distinguish the two adductor muscles, by which the animal attaches itself to the walls of its shell, and which are united by a horny collar; and within the shell itself we may notice on either side the impressions of these attachments, sunken into the pearly walls. On the outer side of the head-cartilage and its projections towards the siphon is found another important muscle, that of the neck or collar, which resembles the cartilaginous neck-plate of the dibranchiata. Other strong muscles arise from the surface of the two siphon cartilages and form an organ more or less completely tubular—the *siphon* (xxiii, 9)—the important means of conducting the respired water when driven out from between the body and mantle by the contraction of the latter, and serving as a swimming organ also, by the same action performed with greater vehemence. In swimming, the aperture of the *funnel* or siphon is normally directed towards the head, and its discharges cause a series of rapid backward motions, but the animal is able at will to direct the stream to either side, and even to bend the anterior end of the siphon back upon itself to some extent, when it desires to vary the direction of its movement. In some genera a valve is developed within the funnel preventing the reflux of the water. The funnel is entire in the dibranchiates, but cleft in its length in the Nautili; upon its base is found, in the decapod genera, a portion of the curious stiffening processes (appareil de résistance) already spoken of. In Onychoteuthis and Ommastrephes the funnel is lodged in a special cavity in the under side of the head.

The so-called fins or swimming membranes, wanting to nearly all the octopods and the Nautili, exist in all decapods, in their various genera assuming distinctive forms which may occupy either the whole of the sides of the body (xxvii, 46) or only a portion thereof, and even extend behind into a sort of tail (xxvii, 44). These membranes in Loligo, Ommastrephes and in Onychoteuthis are formed of transverse muscular layers covered with a very thin epidermis, their surface striated by the muscular fibres beneath. These fins are not contractile, but invariable in form; they are firm and coriaceous, their edges are always entire

and very thin. In Sepia the membrane part is covered with a thick skin which extends beyond it. The firmness of the fins seems to be in direct relation to the habits of the species; thus the pelagic genera, encountered only on the high seas and possessing the power of darting to some height above the water, are furnished with the most coriaceous fins; whilst those of the littoral genera are of a softer consistence. Whilst these natatory lobes are of secondary importance as means of locomotion, they serve additionally as a parachute to preserve the position of the body in the water, and to vary the same according to the desire of the animal; their rapid undulation, commencing from the front or hind part, according to the direction in which the animal wishes to progress, is of course, of considerable aid in navigation.

The *arms* (xxvii, 48), are at once organs of locomotion, either by swimming or crawling, of touch and of prehension. In the tetrabranchiates they are multiplied in number but reduced in size and strength, being short, cylindrical, without cupules or sucking-disks, and retractile into distinct sacks (iv, 62); in the dibranchiates they are of definite number, namely *eight sessile* or non-retractile arms; with the addition of *two*, generally much longer, retractile, *tentacular arms* (xxvii, 48) in some of the genera; and these are all provided with suckers or organs of prehension.

The arms of the octopods (xxiii, 1) are longer, more fleshy and altogether better adapted to their creeping locomotion, and to reaching out from their rocky hiding-places to seize the passing prey; whilst the comparatively shorter arms of the decapods are compensated by the two generally very long, retractile *tentacles*, the swimming membrane, the more cylindrical narrow body, and the stiffening of the cuttle-bone or pen, in adapting them for their pelagic life.

The internal face of the arms is provided with *sucking-disks* or *cups* (xxiii, 4) intended to retain objects with which they may be brought in contact. The cups are sessile and fleshy only in the octopods, and they are pedunculated and then furnished with an internal corneous ring, armed with a serrated edge (xxv, 22), or with a corneous hook in the decapods (xxvii, 43).

In Eledone and Cirroteuthis the sessile cupules occupy a single median line on the arms, whilst in the other octopod genera they are in two or more parallel lines. In Octopus they are infundibuliform, shallow, with a depressed radiated surface. In Argonauta these cups are slightly narrowed at their base, and in Philonexis (Tremoctopus) they are cylindrical and extensible. The sessile suckers are powerful means of prehension; they act like cupping-glasses by the withdrawal of a central plug.

The pedunculated cupules of the decapods occupy alternately,

two lines in all the genera except Sepia, in which they are in four lines. Always very oblique, raised on a narrow excentric stalk, they are fleshy, marked externally by a thin margin which confines a corneous ring, in the middle of which is an elevated surface. The functions of these cupules compared to those of the octopods appear to differ in this respect, that they cannot hold by suction, being prevented by the thin border and corneous ring, but in lieu of this means of prehension they have the ring itself powerfully armed with recurved points, and greater facilities of attachment on account of having the cupules pedunculated and movable, instead of sessile as in the octopods. In a state of repose these formidable rings are covered by their fleshy borders; the latter are only contracted when their weapons are to be used.

Whilst the corneous circle or ring exists in all decapods, it is modified nevertheless in the different genera. Enoploteuthis, and the fossil Belemnites offer a curious modification of structure of the corneous ring, which has disappeared apparently, and is replaced by powerful recurved hooks, which are really the two halves of the ring applied closely together. These hooks are retractile or extensible at the will of the animal, and when retracted are totally enveloped with flesh—recalling the velvet cushion of the paw of a cat.

The tentacular arms or tentacles of the decapods, always arising from subocular sacks in the circle of sessile arms and between the third and fourth pairs of the latter, are entirely retractile in Sepia, in Sepiola and in Rossia, and only partially so in other genera. Very long (in Chiroteuthis six times the length of the body), they consist of a rounded or compressed stalk, generally without cupules, and an expanded and thickened extremity or *club*, armed with cupules upon its internal face. These cupules or hooks are very unequal in size and occupy four lines upon the club in Loligo and Ommastrephes, six in Histioteuthis and six or ten in Sepia, Sepiola and Rossia. Onychoteuthis, Enoploteuthis, Celæno and Belemnites have hooks, in two rows; and in the two former there is additionally a group of small cupules and tubercles at the base which may be used to form by the apposition of these parts in the two tentacles a sort of fleshy articulation and support for the action of the armed clubs. Chiroteuthis has an additional oval fleshy cupule at the extremity of the club.

The *web* which connects the arms in many of the cephalopods may be likened to an umbrella of which the arms themselves may represent the ribs. It is but little developed in some genera, but attains an enormous development in Cirroteuthis (xxiii, 7), where it unites all the arms to nearly their tips; and in species

of Tremoctopus it is only developed between the dorsal or superior arms (xxiii, 8).

The modification of one of the sessile arms of the male Cephalopods for sexual purposes, causing it to assume a totally different appearance, will be more appropriately treated under sexual organs.

The tetrabranchiates, of which the Nautilus is an example, (iv, 62), develop a *sheath*, in the margin of which are digitations, eight in number, and from these digitations project in a double series, thirty-six small unarmed *brachial* tentacles, lamellated on their inner surface, and retractile at the will of the animal. This sheath expands greatly dorsally, forming a triangular, tuberculate, fleshy *hood*, by which the aperture of the shell may be closed in lieu of an operculum. In addition to the brachial there are other tentacles; namely, four groups of twelve or thirteen each, termed *labial*, and surrounding the lips, and four *ocular* tentacles, situated one in front and one behind each eye, and which appear to be organs of sensation. In the male there is some modification; the internal tentaculiferous lobes are wanting, and the external ones are divided into an anterior with eight and a posterior one with four tentacula. Upon the left side, moreover, the four posterior tentacles are modified into a peculiar hectocotyle termed a *spadix*, bearing a discoidal follicular gland upon its outer surface.

ORGANS OF MOVEMENT IN THE GASTROPODA, ETC.

Foot. The *foot* is a fleshy, expanded mass, forming the entire under side of the body, or attached to it in front of the mantle by a peduncle. In the heteropods, etc., the foot is divisible into three portions, termed, respectively, *propodium*, *mesopodium* and *metapodium;* but in most typical gastropods these three areas are blended in the sole, although the metapodium is indicated by the fact of its supporting on its dorsal side the operculum. In Strombus (iii, 49), a transverse furrow separates the mesopodium from the propodium, and the metapodium is covered downwards and in front by the operculum.

The peduncle of the foot, when differentiated, is usually short and depressed, and covers the under side of the body between the mantle collar and mouth, the foot being expanded forward, but more extensively backwards; but in Strombus and its allies the foot is slim and cylindrical. Haliotis, Patella and Chiton have the foot, on the other hand, very much expanded. Rapidity of motion appears to be in inverse ratio to the size of the foot; those genera in which the organ is enormously developed, especially in those just cited, where it occupies the entire ventral surface of the body, being slow in movement.

Frequently the anterior border of the foot is variously lobed

and these lobes are mostly of glandular structure, though Keferstein has found them in Buccinum to consist of interwoven meshes of muscular fibres, in which are lodged beautiful nucleated cells. These lobes or filiform processes, like those of the mantle, are tactile organs.

When the foot is greatly expanded, as in Cymba, Harpa, Dolium, etc., it is generally laterally recurved over the shell, somewhat like the mantle in Cypræa and Marginella. In Oliva (iii, 46), and in Ancillaria, the propodium, represented by triangular lobes, lies flat, while the distinctly separated mesopodium covers a portion of the sides of the shell. In Natica the propodium is greatly developed forwards, extending beyond the head and reflected backwards over the latter in such manner as to conceal it, with its tentacles, and the anterior part of the shell itself, from view (lxiii, 41). The mesopodium in Natica, being likewise largely reflected over the shell, the respiratory cavity is covered, but a canal is developed between the reflected propodium and the mesopodium, which conveys water to the branchiæ.

There is a rounded glandular opening in the sole of the foot of many gastropods (Pyrula, vii, 85), which is the external opening of the pedal aqueous vascular system; to be more particularly noticed hereafter.

Nearly all of the prosobranchiates whilst in the larval state support an operculum on the dorsal side of the metapodium; with some, the operculum is fugacious, being lost in the transformation of the animal, yet it continues present in most of the groups. The opercular mantle sometimes extends beyond the borders of the operculum itself, and is divided into processes or filaments, which may, as in Ampullaria, be reflected over it.

The foot is the organ of locomotion of univalve mollusks; the anterior portion is protruded, and then by means of wave-like muscular contractions of the sole, the whole mass of body and shell is brought forward—when the former motion is repeated. In Phasianella, and many other genera, the foot is divided lengthwise by a furrow, and when in motion the muscles of the sole are alternately used on either side, so that the effect of the motion is that of a pair of feet. In attached shells, like Vermetus, the foot is only rudimentary and serves merely as a support to the operculum.

In retiring within the aperture of the shell the foot is generally doubled upon itself across the middle, so that its dorsal posterior side, bearing the operculum, comes outermost; but in Oliva and Voluta it folds longitudinally, whilst the quadrate foot of Conus is withdrawn obliquely, without folding, first the right, and then the left side.

In the Scaphopoda the foot is vermiform (iii, 43).

Natatory Lobes. The heteropods or swimming gastropods develop from the ventral portion of their body a vertical fin or swimming disk (lxxxvi, 99), which, in the male only, is furnished with a sucker placed on its margin. Carinaria has also a caudal lobe or tail expansion for swimming.

Opisthobranchiate gastropods are furnished with lateral lobes proceeding from the sides of the anterior portion of the foot, or from the mantle; in Lobiger (lxxxix, 66), a pair of them is developed upon each side of the body.

The pteropods (xlii), develop a pair of dorsal swimming lobes, but the foot is small or obsolete in most of them. In Cleodora it is combined with the fins; in Spirialis a rudimentary foot supports an operculum.

The Columellar Muscle. There is but one attachment of the gastropod to its shell; namely, by means of the columellar muscle, by which the inner face of the columella is directly united with the posterior portion of the body of the animal. It passes underneath the mantle, greatly thickening the body wall, and terminates upon the inner face of the operculum, so that by its contractions the operculum and shell are approximated, and the animal withdrawn within the latter. The form of this muscle depends on that of the shell, and in the conical, non-spiral shells especially, varies greatly from its normal development. Thus it is horseshoe-shaped in Capulus (lxvi, 30); it is divided into two portions, one of which lies on either side of the anterior part of the animal, in Fissurella. In Haliotis the animal is coiled around it, and its insertion, instead of being on the columella, is on the middle of the inner wall of the shell itself, upon which it forms a large oval impression (lxxxiii, 11). In the genus Clausilia an accessory spathuliform piece (*Clausilium*, iii, 42), is united to the columellar axis of the shell by an elastic pedicle, and appears to act as a *purchase* in assisting the columellar muscle, when the animal desires to withdraw within its shell.

ORGANS OF MOVEMENT IN THE PELECYPODA.

The foot (iii, 50, 52), is developed in most bivalve mollusks and is extremely flexible, having layers of circular muscular fibres for its extension, and longitudinal bands for its retraction. Its degree of development varies with the habits of the genera; in Pholas, Nucula, etc., it shows a sort of pedal disk, whilst in such genera as Unio, Venus, it is compressed and securiform; in Mycetopus it is very long and much dilated at its extremity; whilst in Lucina it is somewhat cylindrical, and in Mytilus tongue-like (iii, 40, 41). In the attached bivalves, such as Ostræa, it is either not developed or exists in a rudimentary state subsidiary to the glands which secrete the byssus.

In the burrowing species, the foot is large and powerful, and in some of those which excavate cells within hard substances, it is studded with siliceous spicula, which make it an efficient instrument for boring: although it is very doubtful whether this is the only or even the principal means by which the animal works.

Adductor Muscles. These attach the animal to the valves of the shell upon either side, and their contraction serves to close them together. Their insertion is shown by scars upon the valves (ii, 31, 32; iii, 51), and these indicate an important difference in position and in number, useful in the classification of bivalve mollusca. In the *Monomyaria* (ii, 32), the adductor is single and usually subcentral: Ostræa, Tridacna, etc., being examples; whilst in the *Dimyaria* (ii, 31), including most of the bivalves, there are two adductor muscles, situated anteriorly and posteriorly near the margin. The action of the adductors is antagonistic to that of the ligament which connects the valves of the shell, and which passively opens them. Their contraction is rapid and powerful, exerting a force which is enormous, when compared with their size and weight; according to the experiments of M. Leon Vaillant made at Suez, a Tridacna, 21 centimetres long, and the muscle of which weighed but 39 grammes, lifted a weight of 4914 grammes by its contraction. In *Pecten varius* (ii, 32), two large independent impressions are formed by the adductor, the muscle itself being composed of two elements; there is also in the left valve a third impression produced by the foot. So in Anomia, whilst the right valve has the single muscular impression only, the left valve shows three additional scars, the large central one being that of the muscle of the *plug* (the equivalent of the byssus of Pinna and Modiola), a smaller one within the umbo, and one in the disk being caused by the retractors of the foot. These foot retractors cause scars upon the valves of many of the pelecypoda; in the dimyarians the anterior pair are attached within the umbones as in Modiola or Mytilus (iii, 51), or nearer the adductor, as in Astarte and Unio; the posterior pair are often close to the adductor so that their scars are not separated from it. The Unionidæ have two additional retractors of the foot attached laterally behind the anterior adductor (iii, 52); in Leda, Solenella, and a few others, this lateral attachment forms a line extending from the anterior adductor backwards into the umbonal region of the shell.

At a certain distance within, and parallel with the margin of the shell, is an impression caused by the muscular mantle-margin, and termed the *pallial line* (iii, 31, 32); it connects the scars of the adductors. In the monomyaries it is broken up into an irregular chain of spots. The presence of a *sinus* (iii, 31) in

this line indicates that the animal possesses retractile siphons. The depth of the sinus does not, however, indicate the extent of the contractibility of the siphons, but simply their retractile movements; the very contractile siphons of Mya being much longer, and those of certain Tellinidæ three or four times the length of the shell. The small siphons of Sphærium and Dreissena cause no inflection or sinus of the pallial line. When the siphonal sinus exists, its form is characteristic of genera and species.

In Lucina and other bivalves there are furrowed impressions caused by the viscera; the absence of polish and outline will distinguish these from muscular scars.

Occasionally the foot muscles are attached to prominent apophyses proceeding from the beak cavity; of this nature are the prominent falciform processes or "teeth" of Pholas and Teredo. In Cucullæa the posterior adductor attachment is bounded by a carina or ridge.

It is by the forcible contraction of the adductors that the so-called swimming of Pecten and Lima is accomplished. The motion is really a series of rapid dartings, uncertain in direction. Dr. Fischer remarks that, on account of the peculiar form of the valves of Jouanettia, the hinge-line being short and the shells gaping apart anteriorly and posteriorly, the contraction of the anterior adductors must increase the posterior gap and *vice versa*, the action of the two pairs thus becoming measurably antagonistic. A similar effect is produced in Zirphæa, and indeed in all the numerous species which are termed gapers.

Dr. Lockwood has placed on record * the fact that *Modiola plicatula* when placed in an uncongenial situation, can use its foot, in escaping, with as much facility and in same manner as a gastropod; not only traversing a part of the bottom of his aquarium, but actually gliding up its perpendicular wall to a distance of six inches. Dr. Aug. A. Gould observed *Mytilus edulis* (iii, 40), climb the side of a glass jar by the aid of its foot and byssus, thus accomplishing three inches in a single night. To do this, the animal first stretched out its finger-like foot to its greatest extent, and attached a fibre to the glass, and then withdrew its body within the shell as much as possible, by which the whole was raised about three-fourths of an inch. Numerous fibres were then fixed in a radiating manner until sufficiently secure, and then the whole of the pencil of radiating fibres forming the preceding attachment was thrown off in a mass, at the foot, the ends being still held together by a sort of knot.

* Am. Naturalist, iv, 331.

Dr. Lockwood, in the paper reported above, has witnessed a similar movement by this species.

NERVOUS SYSTEM.

(*Plate V.*) This consists of a group of symmetrical ganglia surrounding the œsophagus, communicating by commissures and sending forth nerves to the various organs. This nervous collar may be considered the representative of the brain of vertebrates. It may be doubted whether the movements of the animal are governed by will to any great extent, most of them appearing to be the reflection of external stimulants, or automatic. The ganglia and the nerves to which they give rise are specialized as follows: 1, cerebral ganglia; 2, the asymmetrical ventral ganglia, branchial, and visceral; 3, the symmetrical or paired pedal ganglia; 4, one or several pairs of small ganglia, called stomatogastric, and connected with the pharynx and œsophagus.

The development of these several ganglia agrees with that of the organs which they serve, and of course where an organ is suppressed, as the foot in the attached oyster, the corresponding ganglia are also undeveloped. Difference in the form of the animals influences also the distribution of the nervous centres, and is mainly shown in the length of the commissure or connectives, which in some cases are very long, in others again, quite short.

The nerves of feeling or sensation are very widely diffused throughout the body. The nerves by which motion is produced are quite distinct from these, yet accompany them so closely as to appear like parts of the same cords.

Cephalopoda (v, 65, 66). The Nervous System is mainly identical with that of the gastropods, yet the relatively high position of the class is shown by the greater concentration of its elements: in the Octopus the cerebral volume is considerable. The cranial cartilage contains a pellucid fluid comparable to the cerebro-spinal liquid of the vertebrates. There are the three typical pairs of ganglia, the cerebral, pedal and visceral, surrounding the gullet and connected by commissures; whilst the nerves which supply the buccal mass, the alimentary canal, the heart, the branchiæ and the mantle develop additional local ganglia.*

* The change of color of cephalopods by the chromatophores (iv, 60, 61) is a case of mimicry, but depends on the pallial nerves; their section paralyzes the dilator muscles of the chromatophores and renders the animal pale; irritation darkens its colors by expansion of the same; intense light paralyzes them also temporarily.

The nervous string in each arm of the cephalopods is a centre for reflex movements, in the same manner as the spinal marrow in the vertebrata, and these movements show the character of protection and defense, like the movements of a decapitated frog.—FREDERICQ, *Archiv. Zool. Exp.*, vii, 535, *Physiology of Octopus vulgaris.*

The dibranchiates have the principal ganglia so closely connected that the commissures are not readily perceived. The optic nerves are well developed. The superior and inferior buccal ganglia have each united in one mass, and the two are united by commissures around the œsophagus. The large nerves of the arms, and those of the funnel or siphon, proceed from the pedal ganglia, which are placed on the posterior side of the gullet; with them are connected also the auditory nerves. From the parieto-splanchnic or visceral ganglia proceed nerves along the shell-muscles to the anterior wall of the mantle, where they enter the large *ganglia stellata;* these are connected by commissures, and send strong cords to the fins. Branches of the parieto-splanchnic ganglia, following the vena-cava, supply the breathing and reproductive organs. A recurrent nerve from the inferior buccal ganglion follows the œsophagus, ending in a ganglion upon the stomach.

A modification of this plan is found in the Nautili. Here a thick transverse cord situated in front of the œsophagus represents the cerebral ganglia; from its outer angles the optic and olfactory nerves proceed, from its anterior edge those of the buccal mass. The pedal ganglia placed close to the cerebral ganglia, are united by a slender commissure; from them are supplied all the nerves of the foot or arms, of the funnel and of the ears. The parieto-splanchnic ganglia, lengthened into a thick cord, united at each end with the cerebral ganglia, form the œsophageal ring. Two large ganglia are found, one on either side of the stomach.

Gastropoda (v, 64, 67). The typical arrangement of the nervous system throughout the mollusca being the same, the differences of which we have occasion to speak are simply modifications thereof. The œsophageal ring consists essentially of three pairs of ganglia and a double commissure on each side, and in the more highly organized prosobranchiates these ganglia are approximated and the commissures shortened until the cerebral mass resembles that of the cephalopods, where the ganglia can be distinguished only by the origin of some of the nerves. In species having a simple mouth, the œsophageal ring surrounds the œsophagus immediately behind the oral mass, but in those having a proboscis or snout, it is situated so far back as to remain at rest whilst the proboscis is protruded or retracted.

The cerebral ganglia are placed above or at the sides of the œsophagus, and from them proceed the nerves to the eyes, tentacles, lips and mouth; the pedal ganglia are under the œsophagus, and from them the acoustic and pedal nerves arise; the visceral ganglia are mostly at the under side, somewhat above the pedal ganglia, and here the nerves supplying the mantle, branchiæ, viscera, heart and columellar muscle take

their origin. Almost all of the nerve-cords arising from these three ganglionic pairs may also develop ganglionic enlargements whence numerous nerves in their turn originate. Such is the general plan of the nervous system in prosobranchiates, differing but little from that of the lamellibranchiates or bivalve mollusca.

The most important modifications of this arrangement are found in Haliotis, Fissurella and Chiton. In Haliotis the cerebral ganglia are dispersed, not very distinct, but united by a large commissural loop, whence proceed the nerves of the cephalic tissues and organs. The subœsophageal mass furnishes on either side a very large trunk consisting of two superposed nerves: the pallial and pedal, the latter being united by numerous transverse commissures. The commissures of the visceral ganglia are crossed.

According to the observations of von Jhering the pedal ganglia of Fisurella are elongated and united by a series of transverse commissures.

The nervous system of Chiton (v, 68) shows a simple loop passing over the œsophageal bulb, and united below by a commissure. These mollusks have neither eyes nor tentacles and their mouth is reduced to a simple orifice, consequently the cerebral ganglia are atrophied. The pedal nerves are united by transverse commissures, as in Haliotis and Fissurella and in the annelids.

In the opisthobranchiates, the ganglia are closely joined, yet distinguishable. The cerebral ganglia are placed above and in front, the visceral below and in the rear, the pedal without; the two latter connected from side to side by commissural loops. From the cerebral ganglia arise olfactory nerves, which develop a large special ganglion in their course. In Aplysia and Bulla there is a very large genito-branchial ganglion, distant from the subœsophageal ring, with which it is united by a double commissure. In Tethys the ganglia are fused into a single body, furnished with a commissure forming a nearly complete circle.

In the pulmonifera or snails (v, 67), the cerebral ganglia are distant in Limax, Vaginula and Oncidium, but join, without commissure in Glandina, and Testacella. Two commissures proceed from each of these ganglia, the first joining the pedal the second the most anterior of the visceral ganglia of its side. Three additional visceral ganglia, with the two pedal ganglia form a subœsophageal ring, united by commissures as in Limnæa or Zonites, or close without connectives as in Glandina and Testacella. Through the midst of the circle passes a branch of the aorta. It will be seen that the visceral ganglia are five in number; their disposition is usually two on the right and three on the left side in snails having dextral shells and *vice versa* in ose having sinistral shells. These ganglia innervate the

mantle, lungs, genital glands and viscera. In Limax, Arion and Oncidium they are placed below and more or less mask the pedal ganglia. The stomato-gastric ganglia are small and usually united by a transverse commissure (absent in Testacella and Glandina); they furnish nerves to the œsophagus, salivary glands and lingual sheath.

Pteropoda. The nervous system is analogous to that of the gastropods, the thecosomata (Hyalea, Cleodora, etc.) having affinities with opisthobranchiata; the gymnosomata (naked species) with the pulmonifera.

Scaphopoda. In this small group the nervous system resembles that of the lamellibranchiates. There are four much dispersed ganglionic centres: the buccal, pedal, anal, and stomato-gastric.

Pelecypoda (v. 69). The cerebral ganglia of the bivalve mollusks are, as might be expected, small; they are united by a loop or commissure varying much in length, being long in Anodonta, for instance, and so short in Mactra that the two ganglia may be said to touch. They furnish nerves to the mouth, labial palpi and anterior portions of the mantle. Commissures unite the cerebral and pedal ganglia. These connectives are long in those species like Mya and Modiola, in which the foot is distant from the mouth; short in those in which the two organs are proximate, as in Teredo; atrophied in those in which the foot is rudimentary, as in Pecten and Ostrea. The pedal ganglia are two in number but joined closely, or in Anodonta, soldered into a single mass. The commissures uniting the cerebral and branchial ganglia are extremely long. The latter, two in number, are situated in contact with the posterior adductor muscle. In Ostrea, Pecten, Avicula and Mytilus they are united by a short connective, in Anodonta, Mactra and Mya they are contiguous. In Teredo, which has relatively very large branchiæ, there is one on each side of an accessory branchial ganglion. These ganglia furnish not only two great trunks proceeding to the branchiæ, but also the nerves of the posterior adductor muscle, of the siphons, heart, rectum, etc. A large number of small ganglionic swellings occur in the course of these nerves.

The splanchnic nerves proceed from the pedal or branchial ganglia, and not from special ganglia as in the encephala.

Phosphorescence. Pliny appears to have been the first naturalist who noticed and recorded the fact that the Pholas, a lamellibranch or bivalve mollusk, emits a phosphorescent light. This faculty is shared by a number of pelagic gastropods, colonies of which illuminate at night large portions of the surface of the ocean, so that sometimes a ship appears to pass through a sea of fire. The Pholas retains its luminosity after it has been cut into fragments, and even after it has been dried, it will

recover this faculty, according to Réaumur, upon being again moistened.

Phillirhoë bucephala, a pelagic mollusk inhabiting the Mediterranean, exhibits this quality in a remarkable degree. It suffices to plunge it into fresh water to excite its luminosity, and the addition of a drop of ammonia will cause its entire surface to become resplendent for some time with a lively, bluish light.

Panceri has shown that the phosphorescence of Phyllirhoë proceeds from special cellules provided with a golden yellow pigment, and analogous to the chromatophores of cephalopoda. These *Cellules of Müller* are in intimate relation with small ganglionic swellings of the peripheric nerves, and it has been advanced as probable that the phosphorescent emission is excited by the nervous system.

ORGANS OF SENSE.

Touch. Cephalopoda. This is, of course, the most widely diffused of the senses in the mollusca, every portion of the body being extremely sensible of contact with external objects, but in the Cephalopoda the arms may be considered as specialized tactile organs; the Octopus, for instance, using its dorsal pair of arms in like manner with the horns of the snail or insects in exploring neighboring objects.

Gastropoda. The principal tactile organs are the tentacles (vi, 72), and edge of the mantle, which is frequently fringed (iii, 45); but there are in addition, in certain prosobranchiates lobular productions of the head near the tentacles, which appear to have a similar function (plate 3).

In the prosobranchiates, the tentacles, always two in number, are solid structures, not invaginate and capable of retraction within the head as are those of the pulmonates; they arise from the front dorsal part of the head and in the proboscidiferous species are situated at the base of it. The tentacles usually bear the eyes upon stalks which are connate with or branch out from them. The position of the eyes varies in different genera; thus they are found near the bases of the tentacles in Littorina, Dolium (lxii, 21), or near the middle, as in Murex, Fusus, Cassis, Mitra, etc., or even at the end, as in Terebra. In Strombus the robust eye-stalk originates about the middle of the filiform tentacle (lix, 56). In many holostomates, as Trochus, Nerita (lxxviii, 57), Ampullaria, Paludina, etc., the *ommatophores* are entirely separate from the tentacles.

The tentacles are sometimes delicately hairy, and these hairs are evidently tactile also. In the same category of tactile organs must be included the lobes, filiform processes, etc., of the mantle-margin, as well as the processes which beset the mantle lobes of

Cypræa, which lobes are thrown over the back of the shell so as nearly to cover it (lxi, 99). The anterior lobes of the foot existing in many mollusks, as in Buccinum and Harpa for example, may also be regarded as tactile in function.

In the nudibranchiates, besides the various appendages or prolongations of the mantle-border, there are dorsal tentacles (*rhinophores*, vi, 79), situated near the head, and certainly organs of touch.

The Pulmonata or snails are provided with very sensitive tentacles (vi, 72), those of the terrestrial species being invaginate and combining in addition the organs of vision and possibly of smell; while the aquatic species, Physa, etc., have the eye usually separated from the tentacle. Glandina, which is one of the few carnivorous Pulmonata, has remarkably developed labial palpi, resembling enormous moustaches (vi, 72). These palpi, says Fischer, are in ceaseless movement whilst the animal is crawling; and when it approaches another mollusk (Bulimulus or Helix), these organs are applied first to the shell, then to the body of the victim, which is soon drawn, in part, across the extremely dilated mouth of the Glandina. A very large nerve proceeding from the cerebral ganglions is distributed through the labial palpi, the sensibility of which must be extremely delicate.

Pelecypoda. The fringed border of the mantle is very quickly retracted wherever touched. In the Pectens and Limas, which swim rapidly, these fringes are greatly developed. In Unio and Anodonta they are so sensitive as to perceive the slightest movement of the water in which they exist. The extremity of the foot, in the Unionidæ is also very impressionable (Baudon).

Organs of Sight. Cephalopoda (vi, 70, 71). The two sessile eyes are lodged in orbital cavities on either side of the head, in the dibranchiates; in the tetrabranchiates they are elevated upon peduncles. In the former case the cephalic cartilage, as we have already seen, partly encloses them, whilst in some instances special orbital cartilages are also present; the enclosure is completed by a fibrous capsule continuous with the cephalic cartilage, which becomes transparent over the eye and is likened to the cornea or even to the eyelid in vertebrates. This transparent capsule presents several modifications; it may be entire or with a small perforation as in the Octopods, in Sepia, Loligo and other genera, constituting the division *Myopsidæ* of d'Orbigny; or it may have a wide opening, for the projection of the crystalline lens, as in Ommastrephes, Loligopsis, etc.—the *Oigopsidæ* of d'Orbigny: it is entirely wanting in Nautilus.

We find in the dibranchiates a large portion of the eye-chamber occupied by the optic ganglion, by ocular muscles and by a white glandular substance. The silvery *tapetum* lines but does not adhere to the ocular capsule; its two layers pass into one

another at the edges of its free prolongation, which forms the *iris*, and between these two layers occur longitudinal muscular fibres. A layer of cartilage underlying the tapetum, forms the *inner ocular capsule*, which extends externally as far as the iris, and is penetrated on its inner side by the fibres of the optic nerve. The *ciliary body* is formed of connective tissue with muscular fibres and is placed, as a thick rim, upon the free edge of the inner capsule. The *lens* is composed of layers of structureless membrane, which are cuticular productions of the ciliary body; it is almost cylindrically elongated in the direction of the axis of the eye. The vitreous humor is a transparent fluid. The *retina*, lining the inner capsule, has an outer and an inner stratum, separated by a pigment layer. The inner stratum is composed of prismatic or cylindrical rods, the inner ends of which, turned towards the ocular cavity, are covered by a membrane; the outer stratum is filled with the plexus of the optic nerve fibres and with ganglionic cells, connected by tissue; thus the nerve terminations must penetrate the pigment lying between the two strata of the retina in order to reach the rods in the inner stratum.

The pedunculated eye of the Nautilus is much simplified in its structure, having neither cornea, lens nor vitreous humor. The creeping habits of the animal, the abundant protection afforded by its external shell, its want of offensive armor upon the tentacles are here found correlative with a degradation of the visual organ.

A great difference in the size of the eyes in the pelagic and littoral genera accompanies the difference of habit. The littoral Octopus, always existing where the light of the sun penetrates with more or less power, has small eyes, whilst they are enormous in those genera which inhabit the high seas, penetrating to great depths, and which are evidently nocturnal in their habits. So also we find the situation of the eyes to differ according to the habits of the cephalopods: thus the shore species, especially the creepers, have their eyes placed laterally on the back of the head, that they may look above and around, but not below them, whilst the swimmers on the contrary have their large eyes placed directly on the sides of the head to give them equal visual powers in all directions. The eyes in the octopods are fixed, without movement, whilst in the decapods they are free and capable of movement; in the former the skin is susceptible of contraction, so as to cover the eye entirely, fulfilling the functions of an eyelid; whilst in the latter the littoral species are furnished with this protection, but the pelagic ones are without it.

Gastropoda. We have already seen that the eyes are variously situated upon or branching from the tentacles (*ommatophores*)

in most cases; in others they are sessile or nearly so, upon the head, and situated behind and outside of the tentacular bases. Tentacles and eyes are both wanting in Chiton.

The eyes are spherical, oval, or conical structures, embedded in the skin of the eye-stalk in such a way that the epithelium of the stalks covers them. Externally they are enveloped by a firm laminated membrane (*sclerotica*) which becomes thinned out anteriorly to a cornea. Internally the sclerotica is covered by a pigment contained in polygonal cells, the *choroidea*, which extends forward to the *cornea*, and since the cornea does not cover the whole of the external side of the eyeball but only its middle, a dark pigment ring is seen at its border, which might be described as an *iris*, but cannot be considered equivalent to the same structure in higher animals. In Strombus this iris-like ring exhibits strikingly brilliant colors, yellow, red and green; often several colors appear in separate rings behind each other, numerous instances of which are figured by Quoy and Gaimard in the Voyage de l'Astrolabe, and used by them as specific characters. In this eyeball, just behind the cornea, the lens is placed, which is nearly spherical and consists of concentric layers. The posterior part of the eyeball is occupied by the so-called vitreous or glassy body which Keferstein regards as a retina.

The eyes of the land snails or Helices (vi, 72, 73, 74), are placed at the extremity of their tentacles or feelers, and can be retracted entirely within the head by invagination, a process which may be likened to drawing in the finger of a glove (vi, 74). The transparency of the horns of a snail is such that invagination may be readily perceived, by touching them and watching the black eye-bulb descend through the constantly shortening stalk, until concealed under the skin of the head. This contraction takes place in a manner which completely changes the relative positions of the crystalline lens and ocular bulb or special retractor muscle of the former, causing it to descend in advance of the latter, which is, morever, drawn to one side and partly upset in position in descending. Janthina and most of the pteropods, the large Auriculæ, Natica, Sigaretus, Bullia, Chiton, Lepeta, etc., are blind, and in Doris the eyes are covered with a very thick integument, so that vision must be limited to a vague perception of light. In certain genera and species of pulmonates, or land snails confined in habit to grottoes and caverns the eyes are very imperfect. Even a species of Helix, a genus usually so well provided with vision occurs in the grottoes of Carniola with imperfect organs. Certain gastropods exhibit a character of inferiority in the multiplication and diffusion of their visual organs, which appears to ally them to the lamellibranchiates: for like them, the ocelli of Trochus, Margarita, the

nudibranchs, and Oncidium occupy various portions of the surface of the mantle.

The Scaphopoda are structurally degraded; the head is rudimentary and possesses no eyes.

Lamellibranchiata. Some of the mollusca which in the adult state are blind are provided with excellent organs of sight during their more active larval existence. Thus, larval lamellibranchiates have a pair of eyes near the mouth, which are wanting to the adults. However, this loss is compensated by the development of numerous ocelli on the mantle-border. These are particularly apparent in Pecten (vi, 75), and Spondylus, varying in number on the two sides of the body in the inequivalve species: thus, *Spondylus gæderopus* has sixty ocelli on the right or fixed side, ninety on the left side. Small eyes are developed also upon the tentacles or papillæ sometimes ornamenting the extremity of the siphons, as in *Cardium edule*, the Unionidæ, etc. The structure of these ocelli is similar to that of the eyes in gastropods.

Auditory Organs. The organs of hearing in mollusks consist of a pair of sacks or *otocysts*, containing a liquid in which is suspended one or several calcareous concretions termed *otolites*. The walls of the otocysts have a vibratile, ciliated epithelium causing a constant movement of the liquid which they contain. A special acoustic nerve supplies the organ.

Cephalopoda (vi, 71). In the dibranchiates the auditory sacks are lodged in cavities of the cephalic cartilage: they each contain a single, large, calcareous otolite. In the Nautilus, however, these sacks are found attached to the pedal ganglia, and contain numerous otolites. The external ears are hollow, plicated processes on the side of the eyes, communicating through a passage lined by a glandular membrane, with the auditory sacks.

Gastropoda (vi, 77). Souleyet first detected auditory organs in univalves, and Siebold, Krohn, Kölliker, Schmidt, Lacaze-Duthiers and Jhering have so multiplied observations upon this point, that their existence in all prosobranchiates may be considered highly probable.

Two auditory vesicles usually exist, and very generally appear to be sessile upon the pedal ganglia, where they appear as small white points. In the heteropoda, in many nudibranchiata, as shown by Hancock, and in numerous genera of branchio- and pulmo-gastropoda, which have been carefully examined by Lacaze-Duthiers, however, there seems to be no doubt that the auditory nerves arise from the cerebral ganglia, even though the vesicles may be situated close to the pedal ganglia.

Within the vesicles are found, in many univalves a single large, somewhat spherical otolite, whilst in others numerous smaller ones exist, amounting to fifty, to a hundred in some

pulmonates, or even, as in the oriental Melania and Melanopsis, a large laminated otolite together with small crystalline ones. The auditory nerve divides upon the vesicle into a number of branches; and the vesicles are probably connected with the external world by means of an auditory canal; at least such a canal exists (according to Ad. Schmidt) in Helix, and Kölliker discovered it in the cephalopods.

The Pteropoda and Scaphoda are provided with similar hearing organs.

Pelecypoda (vi, 78). There is a single auditory organ wanting however, in the adult stage in those genera which then become fixed; it is found in the neighborhood of the pedal ganglia, or even as in Sphærium, joined to them.

Notwithstanding the existence of hearing organs in the lamellibranchs is so definitely ascertained, they appear to be entirely insensible to sound, although the Anodonta is tactilely aware of vibrations of the air.

Olfactory Organs. That the sense of smell is well developed in many mollusks has been experimentally ascertained, but the location of the organ has not been satisfactorily demonstrated. Moquin-Tandon relates that a naturalist, observing an Arion (garden-snail) moving in right line towards a pea-pod, from which it was two yards distant, picked up the pod and placed it in his pocket. The animal presently halted, and raised its head and directed its horns towards the now unattainable luxury. The pod was now replaced on the earth in another direction and hid by a stone, but the animal was not at fault and turned again in quest of its food. A new change of position of the morsel determined another itinerary, and finally the Arion was allowed to enjoy its well-earned meal. Fischer has witnessed the rapidity with which numbers of *Nassa reticulata* assemble around the putrefied carcass of a fish when thrown into the water. They make towards it immediately, from all quarters. On the English coast *Fusus antiquus* is gathered by means of carrion. Whelks (*Buccinum undatum*) are very troublesome to the lobster-fishers, for they often devour the bait, and at St. Margaret's-at-Cliffe, on the Kentish coast (England), the lobster pots are sometimes drawn up, one after the other baitless, and full of these greedy mollusks (Lovell). Even some lamellibranchs appear, by their partiality for putrefying flesh to possess a sense of odor.

The lamellated tentacles or rhinophores of some of the opisthobranchiate gastropods have been supposed by Hancock and Embleton to be olfactory organs (vi, 79). Their nerve is large and provided with a large ganglionic swelling. They are retractile within a special cavity. In the pulmonta geophila, Moquin-Tandon supposes the bulb-like extremity of the ocular tentacles to possess olfactory functions: he finds that after

amputating the tentacles the animal is no longer able to direct its movements towards savory and odorous morsels as did the Arion mentioned above. Dr. Sochaczewer of Berlin, however, does not believe the olfactory organ in terrestrial mollusca to reside in the tentacles. A Helix deprived of its tentacles nevertheless manifested perfectly its repulsion for the odor of turpentine, yet a small rod dipped in the essence was held between the tentacles of another Helix without the animal manifesting any sensibility of its vicinity. Dr. Leidy locates the sense of smell in a "blind sac or depression opening below the mouth," the mucus canal or *Sinus of Kleeburg*. In the fresh-water pulmonates, Lacaze-Duthiers locates the olfactory organ in a depression of the external side of the basal enlargement of the tentacles.

The seat of the organ in the prosobranchiates and lamellibranchiates has not been determined.

Kölliker has made the interesting discovery that a pair of pits or papillæ, as the case may be, situated behind or above the eye in the Cephalopoda, are olfactory organs. They are pits above the eyes in the Teuthidæ and Sepiadæ and in some of the octopods, but in Argonauta and Tremoctopus they are developed as papillæ, and in Nautilus are elongated like small tentacles, placed immediately behind the eyes. D'Orbigny has mistaken them for external ears.

Many of the mollusca give forth a perceptible odor, agreeable or otherwise, such as the musky smell of the Eledone squid and of the snail *Hyalina fragrans*. Another snail (*Helix fœtens*) is fetid, several give out an odor of garlic, *Bulimus decollatus* resembling laudanum, and Clausilia and Pupa something like sperm.

Apropos to this subject is the following "Note on the Origin of Ambergris," published by Mr. H. Crosse in *Jour. Conchyl.* (3 ser., iii, 204, 1863):

All the world is acquainted with ambergris, so frequently used as a perfume, either singly or in combination with other substances; but the singular conditions under which it is produced are by no means so well known. It is produced by the cetaceans called cachelots, and is simply a result of digestion, a sort of intestinal calculus, a coprolite. This has been confirmed by numerous observers, including both scientific men and whalers. It is formed into balls of various sizes in the digestive canal and appears with the excrement. It is probably caused by an unhealthy state of the animal, as the quantity differs in different individuals from a few to a hundred kilogrammes, according to whalers, and some animals have none. It is encountered in many parts of the world, floating on the surface of the water, than which it is much lighter. And now for the connection of

this substance with our subject. The Cetaceans consume large quantities of cephalopods as food, and many of these latter when living exhale a strong odor of musk; among these may be especially mentioned *Eledone moschatus*, and the gigantic *Loligo Bouyeri*. Now amidst the ambergris are found portions of the corneous mandibles of cephalopods, which the digestion of the whale has not been able to destroy. The ambergris is then, without the least doubt, the result of the intemperate eating of cephalopods. Some of our readers who appreciate the delicate perfume of ambergris, will scarcely thank us for revealing to them in what a singular laboratory it is really prepared; but we cannot change the reality of things—and such persons can, if it seem good to them, employ for the future perfumes of less prosaic origin.

Gustatory Organs. The tongue and mucous lining of the pharynx of cephalopods have been considered to possess gustatory functions, having a crowd of smooth papillæ which probably serve this purpose. That this sense is possessed by the Gastropoda is evidenced by the care and discrimination with which their food is selected, but its special seat has not been determined, for the marine species. Fischer has discovered, in the helices, two small nerves, coming from special ganglia or distinct swellings of the cerebral ganglia, and which penetrate the pharynx; these he thinks are gustatory. The agnatha (Testacella, Glandina), which feed on living prey, do not appear to possess these special ganglia.

The labial tentacles of the bivalves are considered to be organs for discriminating food, but in what way is unknown. They appear, however, to exercise little selection, and swallow anything that is small enough to enter their mouths, including living animalcules, and even the sharp spicula of sponges. In some instances, however, the oral orifice is well guarded.

RESPIRATION.

The respiratory process consists in the exposure of the blood to the influence of air, or water containing air; during which oxygen is absorbed and carbonic acid liberated. It is a process essential to animal life, and is never entirely suspended, even during hibernation. Those air-breathers that inhabit water are obliged to visit the surface frequently; and stale water is so inimical to the water-breathers, that they soon attempt to escape from the confinement of a glass or basin, unless the water is frequently renewed. In general, fresh water is immediately fatal to marine species, and salt water to those which properly inhabit fresh; but there are some which affect brackish water, and many which endure it to a limited extent. The depth at which shell-fish live is probably influenced by the quantity of oxygen which

they require; the most active and energetic races live only in shallow water, or near the surface; those found in very deep water are the lowest in their instincts, and are specially organized for their situation. Some water-breathers require only moist sea air, and a bi-diurnal visit from the tide—like the periwinkle, limpet, and Kellia; whilst many air-breathers live entirely in the water or in damp places by the water-side. In fact, the nature of the respiratory process is the same, whether it be aquatic or aerial, and it is essential in each case that the surface of the breathing organ should be preserved moist. The process is more complete in proportion to the extent and minute subdivision of the vessels, in which the circulating fluid is exposed to the revivifying influence.

The respiratory system is of the highest importance in the economy of the Mollusca, and its modifications afford most valuable characters for classification, the *orders* being founded upon it.

This classification may be thus stated:

MOLLUSCA.

Encephala.

(Provided with a head: shell when present, univalve.)

CLASS CEPHALOPODA.

Order Dibranchiata, Owen. Breathing by two gills or branchiæ.

Order Tetrabranchiata, Owen. Branchiæ four.

CLASS GASTROPODA.

Order Nucleobranchiata, Blainv. Respiratory organs forming a nucleus on the posterior part of the back, simple and sometimes not specialized.

Order Prosobranchiata, M. Edw. Branchiæ pectinated or plume-like, situated in advance of the heart (Sea Mollusks with spiral shells). Includes the Cuvierian orders, Pectinibranchiata, Scutibranchiata, Cyclobranchiata, Tubulibranchiata.

Order Pulmonifera, Cuv. Breathing by lungs. (Terrestrial, or aquatic.)

Order Opisthobranchiata, M. Edw. Branchiæ arborescent or fasciculated, exposed on the back and sides of the body near its posterior end. (Sea Slugs, Nudibranchiates). Includes the Cuvierian orders, Tectibranchiata, Inferobranchiata, Nudibranchiata.

Order Aporobranchiata, Blainv. Respiratory organ little more than a *ciliated surface*, either situated at the extremity of the

body and unprotected by a mantle, or included in a branchial chamber with an opening in front.

Acephala.

CLASS PELECYPODA.

Order *Lamellibranchiata*, Bl. Branchiæ or gills lamelliform, specialized from a portion of the mantle.

MOLLUSCOIDA.

CLASS BRACHIOPODA.

Order *Palliobranchiata*, Bl. Breathing by the arms, assisted by the mantle.

It will be seen that respiration by means of *branchiæ* or gills is the rule with mollusks, those respiring by *lungs* being confined to a portion only of a single one of the five classes, and not including marine species. A few appear devoid of special respiratory organs, that office being performed by the general envelope of the body.

Cephalopoda. The *gills* form a cylinder in Octopus and Sepia, and in Loligo and other genera they are in the form of a half-cylinder; they are two in number in the naked cephalopods, (vi, 80, 82), as well as those possessing an internal shell; and four, arranged a pair on each side, in the Nautilus; hence the terms dibranchiata and tetrabranchiata, forming the highest divisions of the class Cephalopoda. The water finds access to the gills through the large opening between the free anterior ventral margin of the mantle and the body, and it is expelled from the funnel by a muscular contraction of the wall of the mantle; assisted in some genera by a buttoning arrangement described under the head of Cartilages.

The Octopus in repose respires from twenty to thirty-eight times per minute; in movement, fifty times. The respiration of Sepia is, according to Dr. Fischer's observations made at Arcachon, much more active, he counted seventy to seventy-two respirations per minute in the adult, one hundred and forty in young individuals, an inch in length.

Gastropoda (vii, 90, 91). The branchiæ in prosobranchiates are small, leaf-like, hollow prolongations of the mantle, placed in rows behind each other, and are usually contained in a pouch on the dorsal side of the animal, forming the respiratory cavity. In some opisthobranchiates the gills are lodged at the sides of the body between the narrow, collar-like mantle and the broad foot; such is the position of the filamentous branchiæ of Patella and the laminated gills of Chiton. In the spiral species the right branchia only is well developed, that on the left side being small

and rudimentary; sometimes, however, as in Turbo and Phasianella, the two gills are brought close together, so as to appear almost as one. In the non-spiral shells, Fissurella, Parmophorus, and in Haliotis, the gills are symmetrical and both well developed.

The form of the depressed respiratory cavity is triangular, in the hinder angles of which the heart and kidney are placed. At the same place also the rectum enters and passes forwards on its right side. At the left side of the same, but attached to its angles, the gills are placed, with the laminæ free and extending into the cavity simple or double, with their basal position in relation with the heart.

On the floor of the cavity, at the right side, by the rectum, lies the vagina or the ciliated furrow of the seminal passages and between these sexual organs and the rectum there is frequently pushed the tubular, inflated excretory duct of the kidney; above on the rectum sometimes lies the prolonged anal gland with its opening in front of the anus, so that the openings of the anus, anal glands, kidney and sexual organs are arranged close together in the above order from without inwards at the right anterior side of the cavity. The covering of the respiratory cavity between the intestine and branchiæ is embraced by the frequently large mucous gland, and between it and the intestine there is frequently a special color gland (Purpura, Murex).

The *respiratory cavity* has its external opening on the back of the neck, under the mantle-border, which is here contracted to form a rounded hole. Sometimes the walls of this opening are produced into a canal or siphon (xlix, 14), and this difference is one of much importance, agreeing with important modifications of the shell, and (excepting Natica) with difference of food. Thus the siphonostomata, as already stated, have the shell terminating in a notch or canal below, and are carnivorous, whilst the animals with a sessile respiratory opening belong to the holostomata, the shells with rounded apertures, and (with the exception of Natica) vegetable feeders. In some of the Murices the canal of the shell is very long, but where the canal is short or the aperture simply notched below it by no means follows that the siphon is short; on the contrary, in Cassis and Dolium it attains an extraordinary length, and is reflected over the back of the shell, so that the borders of its wall become dorsal (lxii, 21).

Although there is no true siphon in the holostomata or herbivorous prosobranchiates, one of the neck-lappets is sometimes curled over, so as to form an analogous organ, as in Paludina and Ampullaria. The in-coming and out-going currents in the branchial chamber are separated by a valve-like fringe developed from the neck-lappet. In Fissurella, Haliotis (and the Scaphopoda) the respired current is still more effectually

olated, as it escapes by a hole in the shell, at or near its apex; onsequently far removed from the point of ingress. Near this perture are found the anal, renal and generative orifices. ibratile cilia on the surface of the branchiæ determine the urrent of water towards the anus after it has completely bathed e gills.

Pulmonifera. The land snails and a large portion of the fresh-ater species possess a lung formed by a folding of the mantle, e interior of the chamber thus constructed being lined with borescent vessels forming small fossets or alveolæ. The ening of this chamber is relatively large, on the right side of e animal, and dilates and contracts at irregular intervals. e air within the cavity appears to be renewed with sufficient pidity by the law of diffusion. In Auricula the respiratory paratus is a true lung, but in nearly all the pulmonifera it is described, and in some mollusks the breathing is performed an organ of an intermediate nature. In Ancylus so equivocal it that it has been called a branchia, a branchial operculum, d a lung. Ampullaria, a fresh-water mollusk, the amphibious ashore genus Siphonaria, etc., possess both a pulmonary sack d a branchia. Littorina, a branchiferous mollusk, usually habits stations where it is out of water a considerable portion each day. I have known specimens to live for months, but thout exhibiting much activity, in the air of Philadelphia— ich is rather dry. On the other hand, *Melampus bidentatus*, pulmoniferous mollusk, inhabiting exclusively the seashores the Atlantic coast of the United States, seeks situations ere at high water it is covered by the sea. Many examples ght be cited of this adaptability in mollusks, and of modifica- n in the breathing organ, which modify the sharp distinction merly supposed to exist between the prosobranchiata and monata. The pulmoniferous Limnæa usually visits the face of the water, from time to time, for the purpose of ewing its supply of air, yet it can pass several days immersed hout asphyxiation: indeed a species inhabiting great depths the Lake of Geneva (*L. abyssicola*) normally supplies its sack h water, instead of air, thus justifying the name pulmo- nchiata, which has been given to the androgynous pulmonata. rrestrial mollusca will survive an immersion of a day's ation in water, during which their teguments have absorbed re than their own weight of the element.*

The production of heat is very feeble in a number of land ils which have been examined by Spallanzani, Gaspard, nter, Becquerel, etc., varying from ·13 to 3·90 degrees above t of the surrounding atmosphere. The Helicidæ of temperate

* Fischer, Jour. de Conch., 101, 1861.

and cold climates are subject to a winter hibernation, and whilst in this state the heart ceases to beat, respiration is nearly suspended, and wounds do not cicatrize. The *epiphragm* or egg-skin with which the animal at this time temporarily closes the aperture of its shell is slightly permeable by air; like the shell it is a production of the mantle, and is in some species thin and cartilaginous (American and most European species), in others opaque in consequence of calcareous elements (subtropical). It is only formed by non-operculate pulmonates, and occasionally, when the mouth of the shell has been closely applied to another shell, or to a piece of wood or rock, sufficient protection is thus obtained and the epiphragm is not developed. In case the weather is very severe, the mollusk gradually retires farther within its shell, constructing additional epiphragms at intervals—always thinner than the first one. Cold is not the only cause of hibernation; dryness and want of food also produce it, and Fischer,* by placing a *Bulimus decollatus* alternately upon very dry and humid ground found that it would form and destroy epiphragms at the rate of ten or fifteen per month. Heat causes a summer sleep or æstivation, but in this the animal functions are much less interrupted.

In the nudibranchiate mollusca the respiratory plumes form tufts or rosettes exposed on the back or sides of the animal (viii, 92); or they are protected by a fold of the mantle (inferobranchs and tectibranchs of Cuvier). Finally Eolis, Elysia, Pontolimax appear to have no specialized breathing organ, unless this office is performed by the dorsal papillæ of Eolis:—it has been doubted, because the animal appears to survive their loss without inconvenience.

Pteropoda. The respiratory apparatus is branchiate when it exists, but is very diverse in its disposition in the different genera. In Clio there is no distinct organ; in Euribia it consists of two naked appendages of the anterior part of the body; in Pneumodermon of a posterior organ, having some analogy to the branchial rosette of Doris; in the thecosomata (Hyalæa, etc.), it is large, describing a regular curve, with anterior concavity, and contained in a cavity of the mantle.

In the *Scaphopoda* there are no specialized respiratory organs.

Pelecypoda (viii, 89; xxii, 65). In the bivalve mollusca, or lamellibranchiata, so called from the form of the breathing organs, the branchiæ are double, placed on either side of the body, and enclosed between the mantle-borders and the interior visceral mass, the latter interposed. Behind the branchial cavity are two tubes (*Siphonida*) or merely two orifices (*Asiphonida*) for the introduction or exclusion of the water destined for respiration.

* Mélanges Conch., 35.

The lower orifice or siphon is afferent or branchial, the upper one efferent or anal. Movement of the water is produced by vibratile cilia which carpet the branchiæ, and which act also in directing the food towards the mouth. In the Siphonida the tubes or siphons are sometimes very long, and either closely united as in *Mya arenaria* (iii, 54), or more or less divergent (iii, 53). Most of the free bivalves are siphonated and the length of these organs depends upon the depths to which the various species customarily bury themselves in sand or mud. *Mactra solidissima*, a common mollusk of the Atlantic coasts of the United States, is frequently washed shoreward by the waves, which in retiring leave it exposed. Its active foot quickly buries it beneath the surface of the sand, where it awaits the subsequent overflows, its sole communication with the outer world being a hole in the surface leading to the siphonal openings. The pressure of a foot upon the circumjacent wet, yielding sand, causes the ejection of the water contained within the branchial cavity, through the efferent siphon, whence it arises in a forcible stream, several inches, or even a foot or more, into the air.

Our fresh-water mussels (Unionidæ) habitually bury a part of the shell in the river bed, but expose that portion enclosing the siphons; a single species of the Ohio River (*Marg. dehiscens*, Say), buries itself beneath the surface, communicating with the water through a hole, like the Mactra.*

Non-siphonated bivalves, or those in which the mantle is divided into two lobes, are provided with valvules or folds which render the respiratory irrigation just as complete.

The respiratory currents have no connection with the opening or closing of the valves of the shell; these movements being connected with locomotion, or efforts for the expulsion of irritating substances. If an Anodonta be placed in a vessel of water into which some fine sand is introduced, the particles will be seen entering the incurrent siphon and repelled from the orifice of the excurrent one: but after the animal has had enough of the unpalatable and irritating food it will close its valves, forcing out the water, and with it the sand, through both siphons.

In Ostrea and its related genera the two branchial leaves of each side are equal and exactly superposed, whilst in the Unionidæ they are unequal, the interior extending further in front than the exterior one; in Petricola the external branchiæ are prolonged posteriorly beyond the line of junction of the four leaves, thus producing a third lateral branchia or a reflected portion of the external branchiæ; in Corbis and Lucina there exists but a single thickened branchia on each side, composed of a number of superposed leaves joined intimately; in Tellina

* Lea, Obs., i, 117.

and Amphidesma the branchia is single on each side, yet divided by an oblique crease into two parts, like the opposite pages of an opened book.

CIRCULATION. AQUIFEROUS SYSTEM.

Cephalopoda (vii, 80, 83; viii, 87, 88). The heart (vii, 83), which is placed on the haemal side of the intestine, receives the blood through contractile vessels connecting it with, and equal in number to the branchiae: these may be regarded as auricles. The branchiae are not ciliated, and are generally if not always themselves contractile. The arteries end in an extensively developed capillary system, but the venous channels retain to some extent the character of sinuses. In returning to the heart, the venous blood is gathered into the *vena cava*, a large longitudinal sinus, which is situated on the posterior side of the body close to the anterior wall of the branchial chamber, and divides into a number of branchial vessels corresponding with the number of branchiae. Each of these vessels traverses a chamber in communication with the mantle-cavity (and which may be considered a *renal organ*), and that portion which comes in contact with the water in the chamber becomes sack-like and glandular. The pericardium and the sacks containing the testes and ovaries, appear to communicate with the pallial cavity either through these chambers or directly.

The blood is a white liquid with a slight tendency to bluish, and contains water 89 per centum, Albumen 3 per centum, Salts and substances incoaguiable by heat 7.5 per centum, Fibrine, etc., .5 per centum. The blood of Octopus is blue, saline, but less bitter than sea-water, and amounts to about one-twentieth of the weight of the animal; it contains colorless globules, which agglutinate together when taken out of the body. The blood passes from the arteries to the veins by true capillary vessels, not by lacunae. The heart beats about thirty-five times a minute.—L. FREDERICQ, *Archives Zool. Exp.*, vii, 535.

Gastropoda (viii, 90, 91). The circulation varies greatly as to complexity, according to the higher or lower organization of the animals. In the prosobranchiates (*Chol.*) the circulation is the most complicated, and yet compared with vertebrates, simple. *Arteries* proceed from the heart to the various organs, where they subdivide and terminate in fine capillary vessels. There are no venous capillaries, and the blood flows freely around the organs in the body. There are valves in the *aorta* and *auricles* of the heart which permit the flow of blood only from the auricle to the aorta. From the body-cavity the blood flows into *veins*, some of which conduct to the branchiae whilst others pass directly to the *ventricle* of the heart. In some genera the arteries do not all end in capillary vessels, but in a portion of them, and espe-

cially in the anterior part of the body these are replaced by lacunæ, as in heteropods and pulmonates, equivalent to both venous and arterial capillaries.

The ventricle is short, conical, with the aorta at its apex with two valves at its origin; and at its opposite blunt end, the rounded auricle, separated by a constriction and like the aorta with two valves at its origin. Sometimes the auricle is divided, a division lying on either side of the heart and receiving each the blood of one branchia. When there are two auricles they surround the rectum, resembling the lamellibranchs in this arrangement.

The auricle always lies in front of the ventricle in the prosobranchiates (as in the pulmonates and heteropods), and therefore the blood flows from before backwards to the heart, whilst in the opisthobranchiates the reverse is the case; and this difference was deemed of sufficient importance by Milne-Edwards to give names to these two orders of branchiferous gastropods.

In prosobranchiates with spiral shells the heart lies behind and below the apex of the respiratory cavity on the left side of the animal, between the anterior portion of the liver and right border of the kidney; in Chiton and other non-spiral genera it is in the median line of the body. The aorta, which arises from the apex of the ventricle, soon divides into two branches, the *aorta visceralis* which supplies the posterior and coiled portion of the animal, its liver and sexual organs, and the *aorta cephalica* which gives off many branches forming a plexus over the stomach, œsophagus, mantle, etc.

Venous capillaries are wanting, as already observed, and the arteries discharge into the body-spaces surrounding the œsophagus, the stomach, the hepatic lobes, the intestine. The blood in the mollusca is typically uncolored; but sometimes bluish and transparent; it is red in Planorbis. Its globules are rounded and finely granulated. By breaking away the shell of a Helix, the circulation of the blood is faintly visible through the thin skin of the body.

Usually there are two large *venous sinuses*, anterior and posterior, from which venous branches collect the blood into two veins, which finally unite in the branchial artery.

The number of heart-beats per minute varies greatly in different species; the marine species have not been extensively investigated. Alder counted 120 pulsations in Vitrina, whilst 20 to 90 pulsations are registered for several terrestrial and fluviatile pulmonates. As excitement or other unusual conditions, as well as the approach of the hibernating period would largely modify the rapidity of the pulse, the mere statement of comparative figures for various mollusks is scarcely scientifically valuable.

Alder records 60 to 80 pulsations in the nudibranchiates. The heart in embryos beats more rapidly than in adults.

The heart is represented, in the *Scaphopoda* by a pulsatile sanguinary sinus, traversed by the rectum and communicating with a system of lucunæ, having no lining walls.

Lamellibranchiates (vii, 84; viii, 89). The blood is usually uncolored or slightly bluish, as in the other classes; in *Arca pexata*, however, it is red—this specimen being commonly called the "bloody clam." The heart occupies the median line: it has a single ventricle, except in Arca, and two auricles. The ventricle is traversed by the rectum, except in Ostrea, Anomia, and Teredo.

Aquiferous System. Cephalopoda. Dorsal *aquiferous pores* are found opening upon the head in Argonauta and Tremoctopus: they communicate with large internal cavities. In Ommastrephes and Tremoctopus anal pores, with small cavities, are found on each side of the siphon; in Onychoteuthis they are placed in advance of it; in other genera they are wanting. The buccal region in Histioteuthis and Ommastrephes has four aquiferous pores, and there are six of them in Onychoteuthis, in Sepia and in Loligo: the other genera want them. Finally, there are branchial pores situated near the bases of the tentacular arms and between the third and fourth pairs of sessile arms: in Sepia, Sepiola and Rossia they communicate with the great cavities in which are lodged the tentacles when contracted; in Loligo the smaller cavity only suffices to lodge a portion of the tentacula, and in Histioteuthis, Ommastrephes and Onychoteuthis the cavity is still more restricted, and only occupies a part of the head anterior to the eyes: wanting in other genera. These pores are probably lubricative in function.

Gastropoda. The aqueous vascular system of the foot and mantle-border forms an important connection between the venous sinus and the external world. It includes one or more pores on the pedal disk of gastropods and lamellibranchiates with direct communication with the body-cavity, and ramifies through the pedal mass (vii, 85). It has been observed as a single pore in Murex, Dolium, Triton, Strombus, Buccinum, and many other genera. In *Nerita canrena* Delle Chiaje saw the water spirted from a number of holes in the foot.

The statement of the existence of the remarkable communication of the abdominal sinus with the surrounding water was received with little faith, and the subject attracted as little attention, though immediately after Delle Chiaje's discovery, R. E. Von Bär had fully demonstrated its existence in the lamellibranchs, until finally Agassiz made known his weighty confirmatory and thorough observations. In *Pyrula carica* and *P. canaliculata*, Agassiz observed a pore in the pedal disk, which

is so large that it will admit a goose-quill, and which is divided into many branches throughout the foot, which open, by means of numerous finer branches, into the abdominal cavity. Agassiz injected carmine or indigo solution through this pedal pore, and it filled not only the pedal canal system, but also the body-cavity and, finally, the whole vascular system. Quite similar relations were found by him to exist in the bivalve genus Mactra (vii, 86). The water actually mixing with the blood in this manner, Agassiz also showed thereby that the blood was exhaled from the body-cavity, salt crystals also being observed, which were derived from sea-water which had been taken up. It has been known for a long time that univalves when removed from the water allow considerable water to escape from them, which runs out of the foot. Agassiz found numerous blood-corpuscles in this water, and there can, therefore, no longer be any doubt that water passes through the pedal pore into the abdominal or body-cavity, where it is mixed with the blood.

On the other hand, the researches of Mr. Wedl have led him to announce the existence in the mollusca of a completely closed vascular system, with capillary networks in the greater part of the organs. The type of distribution of these is extremely variable, and intimately connected with the structure. It is thus that in the Murices the skin of the trunk and of the back is formed of several superposed layers of muscular fibres, crossed in different directions, and that several networks of blood-vessels are likewise superposed in these parts. The vascular networks are superposed in the same manner in the foot of these ctenobranchs. In no part of the skin is there any communication between the veins and the exterior; nor do the veins appear to communicate with the aquiferous vessels. M. Wedl, however, has not been able to determine whether these last open directly into the perivisceral cavity, or whether they are distributed only in the foot.—*Sitzungsb. Akad. Wiss. Wien*, ii, 1868. *Ann. Mag. Nat. Hist.*, 4 ser., iv, 365.

DIGESTIVE ORGANS.

Cephalopoda (ix, 93, 94). The organs of manducation in the Cephalopoda include a corneous or calcareous beak resembling that of a parrot reversed; within which is a fleshy tongue armed with teeth. These parts are enveloped in a large muscular *bulb* which supplies the force to the jaws. External to the beak are two lips, themselves surrounded and protected by an extensible *buccal membrane* (iii, 48), situated between the buccal bulb and the bases of the arms. The buccal membrane, wanting to the octopods, is well marked in the decapods. In development it forms a vast funnel, and in repose it covers all the exterior part of the mouth. It is encircled by eight or ten fleshy appendages,

externally marked by as many muscular ridges which correspond to the bands connected with the arms. The buccal membrane doubtless assists in retaining the food of the animal in juxtaposition with the mandibles, and for this purpose the fleshy appendages are provided at their external extremity in the Calamaries and in Sepioteuthis with suckers similar to those found on the arms.

The *lips*, of which the external one is thin, always short and with entire border, and the internal, in contact with the beak, thickened, fleshy and papillary or ciliated upon its edge, can be contracted over the beak, so as to cover it entirely, fulfilling functions analogous to the lips in mammalia.

The beak is corneous (ix, 95; xxiii, 2, 3), with a more or less calcareous investment in the tetrabranchiates. It differs from the beak of birds in that the superior mandible instead of covering the inferior, shuts within it. The superior mandible is composed of two distinct parts, the one rostral, more or less arcuated, sharp in front, forming behind a hood separated by an inferior expansion varying in length or breadth according to the genus. The inferior mandible, always larger, has a less sharp rostrum, and is also composed of a rostral portion and an inferior expansion; but with this difference, that the lateral part is elongated on each side and forms a wing, varying in form.

The fleshy *tongue* (ix, 98), is armed above with many transverse rows of recurved, spinous teeth, the arrangement of which differs in the various genera. Ordinarily, as in the dibranchiates, we find the series of teeth to consist each of a central one with three side-teeth on either side of it, and sometimes, as in Eledone and Loligo, an additional plate on either side; but in Nautilus we find a modification in five somewhat quadrangular central teeth of which the middle one has the most pointed end, and on either side two long fangs with a much smaller plate at the base of each—in all thirteen teeth in a series. The central teeth, which are simple in Sepia and Sepiola, are tricuspid in Loligo and denticulated in Eledone; whilst the lateral *uncini* are usually claw-like. Fifty rows of teeth may be found on the tongue of the Sepia; their continuous growth compensates the loss by abrasion.

Under the tongue is found a fleshy mass covered with papillæ, which is supposed to be the organ of taste; and in Nautilus we find similar papillæ on the tongue (behind the teeth), to its entrance into the gullet.

The rounded, sack-like *stomach* which is situated towards the middle or end of the body is connected with the mouth by a long central gullet; and the *intestine*, more or less bent upon itself ends in a medial, ventral *anus*.

One or two pairs of *salivary glands* are present in the dibran-

chiates, but wanting in Nautilus. The *liver* is always large; and the two *hepatic ducts* are generally glandular. A large and sometimes spirally-wound *cæcum* is frequently developed from the commencement of the intestine, with which the hepatic ducts communicate. The product of the *salivary glands* is uncolored, limpid and acid, whilst that of the *liver* and *pancreas* is also uncolored and acid, but rarely limpid.

In the tetrabranchiata and the decapoda the *œsophagus* is dilated into a *crop* separated from the stomach by a constriction. The cæcum is small and rounded, and the intestine is twice bent upon itself. The four-lobed loosely racemose liver is lodged in the anterior portion of the perivisceral cavity, and is largely developed. From either side of it spring biliary ducts which open in the large *blind-sack*; the pancreas is found at their commencement.

Gastropoda (ix, 96, 97; xiv, 72, 74, 76; xv, 81, 78). The digestive organs are well developed. The mouth, which is sometimes in the lower plane of the head, and sometimes at the end of a proboscis capable of protrusion and retraction (lxii. 21), is encircled by extensible lips; within, it is often armed with one or several *jaws* (xi, 34, 36), and the tongue usually bears on its upper surface numerous transverse rows of teeth, constituting the *lingual ribbon* (x, 11). The œsophagus is often beset with appendages and salivary glands, and leads to the stomach; whence the intestine turns forward, passing close to the kidney and heart and into the respiratory cavity, the right side of which it traverses and finally proceeds to the anus. The intestine and often a portion of the stomach is embraced by an enormous liver, filling nearly the whole of the first whorl of the shell, and pouring its secretions into the former (and often into the latter also) by several openings. We will successively examine these various organs more in detail.

The *proboscis* is a production of the skin of the anterior or head portion of the body, bearing the mouth at its end. When it remains permanently protracted it receives the name of *rostrum*, that of proboscis being more properly limited to this organ when provided with muscles by which it can be retracted within the body. The typical proboscis is quite characteristic of the siphonostomated prosobranchiates, or those carnivorous mollusks of which the shell is canaliculate or notched at its lower extremity; whilst those animals provided with a rostrum or snout, or with a simple mouth are members of the usually phytophagous holostomata. In Dolium, a remarkable exception, the exceedingly long proboscis accompanies phytophagous habits.

The invagination of the proboscis is effected by means of powerful retractor muscles supplied along its entire length and especially numerous at its base, where the retraction begins. The

protrusion of the proboscis, on the contrary, is effected by pressing forward the blood towards the head, an operation assisted by the contraction of the annular muscles of the fore-part of the body. In Natica, according to Troschel, the invagination of the proboscis commences at its extremity (like that of the tentacles of snails) by means of two retractor muscles attached to the oral mass. The same observer describes a muscular disk on the under side of the proboscis, behind the mouth, in Natica and Sigaretus. This disk possesses suctorial action and probably enables the mollusk to attach itself firmly to the shells of other species when drilling them for the purpose of devouring the soft parts.

The oral mass is usually an oval body formed by invagination of the external skin through the mouth, from the upper posterior end of which proceeds the œsophagus, whilst at the lower posterior end is situated the *lingual sheath*, enclosing the *odontophore*. The wall of the oral cavity is filled mostly with flesh-colored muscles and clothed with an epithelium, which is often covered by a thick cuticula, and furnished with cilia on the roof of the mouth.

The lips form a short hollow cylinder at the commencement of the mouth, made up of longitudinal and annular muscles, the latter preponderating; and sometimes forming a ring-like thickening, which is greatly developed and cleft into lobes in the genus Conus, and forms another kind of sucking-disk, by the use of which the animal assists its locomotion—necessarily laborious on account of the weight of its shell. In the terrestrial branchiferous genus Cyclostoma the snout possesses a similar disk.

Jaws. The inner surface of the lips is sometimes covered by hard plates, which are evidently of much service in grasping and comminuting food. The jaws are attached by their hinder portions to the labial skin or membrane, from the epithelium of which they are secreted. They are hyaline, without structure, and yellowish. Their front face is detached from the membrane and frequently elevated like a scale, bearing sometimes, as in *Dolium galea*, a rounded free hook. In the prosobranchiates the jaws are a pair, situated on either side, but in some of the pulmonates this pair becomes united above, forming a single, arched, superior jaw (xiii, 58, 60).* These cheek plates or immovable mandibles are found in nearly all the tænioglossata, as well in those provided with a *rostrum* (Cyclostoma, Valvata, Rissoa, Jeffreysia, Crepidula, Vermetus, Trichotropis, etc.) as in those with a *haustellum* (Marsenia, Natica, Cypræa, Cassis, Triton, Strombus, etc.) They are apparently wanting in all the rachiglossata (Murex, Fusus, Nassa, etc.). The linear horny plates described in *Buccinum*

* The jaw and lingual ribbon of a large Helix, such as *H. albolabris* or *thyroides* may be readily observed by offering tempting food, such as a piece of lettuce or cabbage, to the animal.

andatum by Cuvier and Valenciennes, are probably appendages of the tongue, and used as a handle in perforating the shells on which they prey.

Odontophore. The odontophore or so-called tongue (xi, 22; xv, 83) is attached to the floor of the mouth. It is usually curved in front, and its margins rolled together into a cylinder behind, which is supposed to open as the tongue grows forward bringing its rows of teeth successively into use. It contains two parallel cartilages, which may be more or less confluent, and which are united towards the middle by fibrous and muscular tissue. "The intrinsic muscles of the odontophore are attached at one end to the posterior and under faces of the subradular membrane, some being inserted into its posterior and lateral portions, and others into its anterior extremity, after it has turned over the anterior extremities of the principal cartilages. Certain of the muscular bundles are also attached to the forepart of the odontophoral cartilages themselves. The contraction of these muscles must tend to cause the subradular membrane, and with it the radula, to travel backwards and forwards over the ends of the cartilages in the fashion of a chain-saw, and thus to rasp any body against which the teeth may be applied. When undisturbed, the radula is concave from side to side, and the teeth of the lateral series, being perpendicular to the surface to which they are attached, are inclined inwards to one another. But when the intrinsic muscles come into action, the radula, as it passes over the ends of the cartilages, becomes flattened, and the lateral teeth are consequently erected or divaricated. The extrinsic muscles pass from the odontophore to the lateral walls of the head, and protract or retract the whole apparatus. They may give the protruded extremity of the radula a licking motion, which is quite independent of the chain-saw action due to the intrinsic muscles."—HUXLEY, *Anat. Invert.*, 490.*

The subradular membrane does not terminate behind with the muscular mass of the tongue, but is continued and invaginated into a pouch called the tongue-sheath. The under wall of the oral cavity forms a muscular elevation, which is frequently semicircular, and above which the œsophagus opens. Troschel has regarded this as an organ of taste, and from its position it may well have that function.

The odontophore, radula or lingual plate, is chitinous, subcorneous, transparent and colorless or yellowish. Its surface is

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* Geddes has recently carefully investigated the mechanism of the odontophore in Loligo, Buccinum and Patella. He does not altogether agree with Huxley as to the mode of action of this organ, but thinks its movements depend on those of the cartilages, whilst Huxley regards the cartilages as passive.—*Trans. Zool. Soc. London*, x, 485, 1879, *with three plates.*

covered by a multitude of siliceous teeth symmetrically arranged in transverse rows. The teeth of the anterior portion of the radula are the most developed but at the same time more worn than those of its posterior portion which have not yet come into use, and the projection of which above the surface is scarcely discernable. These teeth are thus developed behind and are successively taken into use. In the Littorinidæ the lingual plate reaches its maximum development, its length, when uncoiled, being in *Tectarius pagodus* seven times that of the body of the animal. In Patella, Chiton, Cyclostoma, etc., the odontophore is also relatively very long.

For convenience of description the odontophore may be divided into five longitudinal areas, which are crossed by the numerous transverse rows of teeth; these teeth are distinguishable in character in each area (x, 11; xii, 13). The central tooth is termed *median* or *rachidian*, the adjoining area on each side bears the *laterals* or *pleuræ*, and these again are flanked by the *marginals* or *uncini*. Sometimes, however, only three areas are found, when the laterals are suppressed, and a cross series includes only rachidian and uncinial teeth. In Bullidæ again, the rachidian teeth are suppressed and there are simply two bands of uncini, whilst in a few gastropods the tongue is unarmed. A numerical formula has been devised which represents these teeth thus:

In Trochus (∞. 5. 1. 5. ∞.), meaning 1 rachidian, 5 laterals and numerous (∞ being the sign of infinity) uncini. Muricidæ have but three longitudinal areas and the formula for Murex, for example, is 1. 1. 1., signifying one rachidian tooth, with a single marginal on either side.

The following list, compiled by Dr. J. G. Fischer, will give some idea of the number of teeth developed upon the odontophores of several species:

Eolis Drummondi, 16 (Möbius); *Eolis papillosa*, 30 (Möbius); *Buccinum undatum*, 240 (Möbius); *Nassa reticulata*, 267 (Möbius); *Fusus antiquus*, 450 (Möbius); *Subulina octona*, 3025 (Fischer and Crosse); *Littorina littorea*, 3500 (Möbius); *Doris tuberculata*, 6000 (Hancock); *Limnæa jugularis*, 8343 (W. G. Binney); *Oncidiella celtica*, 8384 (Fischer and Crosse); *Bulimus Cantagallanus*, 12,100 (id.); *Helix aspersa*, 14,000 (Thomson); *Zonites eurygomphalus*, 17,473 (F. & C.); *Helix pomatia*, 21,000 (Thomson); *Orthalicus longus*, 23,660 (F. & C.); *Limax maximus*, 28,800 (Thomson); *Tritonia Hombergi*, 36,000 (Hancock); *Helix Ghiesbreghti*, 39,596 (F. & C.).

Whilst the number of teeth (as well as their form) in each transverse row is constant in the individuals of a species, the number of the rows is, of course, variable, according to age and the usage which the ribbon has received; and the above figures

are therefore mostly individual counts which may vary somewhat in other specimens of the same species.

Rev. G. Rowe observes that* "this subject has been investigated by several naturalists, with a view to obtaining criteria for a systematic arrangement of Gastropodous Mollusca. Up to the present time, however, their labors have only partially succeeded. The union under one formula of so many creatures widely differing in shells, anatomy and habits, clearly indicates that if the lingual ribbon contains generic characters, they have not yet been ascertained. At the same time it does present differences which may offer collateral evidence in cases difficult of discrimination. It does not help us to discriminate carnivorous from phytophagous animals; but it seems possible to make use of it as a mark between species."

On Extracting and Preserving Odontophores. If the specimens are large enough, the head may be opened from above, exposing the buccal mass, which lies close under the skin; this is easily cut away from the animal, and will be found to contain both jaw (when it exists) and lingual membrane. These can be removed by fine scissors or knives, but in the smaller species the whole buccal mass, or even the entire animal with the shell may be placed in a test tube, immersed in Liquor Potassæ, and allowed to soak from a day to several weeks until everything is dissolved except the shell, the odontophore and a few shreds of muscular fibre. The contents of the tube being poured into a large vessel of clean water, the odontophore will settle to the bottom, whence it must be carefully taken out by means of a dip-tube and thoroughly washed until all alkali is removed. Alcoholic specimens require boiling in the alkaline solution, but fresh material had better be treated cold, unless time presses, when boiling will facilitate the extraction of the odontophore. In this case care must be taken as delicate specimens are likely to be injured by boiling. When the specimens are very delicate, a solution of less than officinal strength is substituted with advantage; this is a matter in which experience is the best teacher.

The odontophore can be preserved (in either alcohol or glycerine), but in mounting as a microscopic object, glycerine-gelatine should be used. Canada balsam ruins the membrane by rendering it too transparent.†

Through Troschel, in 1836, attention was first directed to the various forms of tongue-sculpture as being available in classification, and Lovén and Troschel himself by means of the most exhaustive investigations discovered the extraordinary multi-

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* *Intellectual Observer*, v, 67, 1864.

† A. M. Edwards, *Proc. N. Y Lyc.*, 160; W. G. Binney, Bull. Mus. Comp. Zool., iv, 42.

plicity of form, etc., of the radula. In their systematic labors Troschel and Gray raised the radula to the rank of a character of the first importance, in the molluscan, especially the gastropod system, and they accordingly made many changes, rearrangements, and improvements.

To be sure, the tongue and its delicate teeth have been long since known, but they occupied only a subordinate place in the minds of systematists. With Lebert we might agree that Aristotle meant the teeth upon the radula (*Hist. Anim.* vi, 4.) "habent quædam os et dentes, ut Limax, acutos et minutos," and not as Lovén held, the jaws, but we meet with a better account of them for the first time in Swammerdam upon Paludina, Littorina and Neritina.

With many other striking observations upon mollusks we meet with the first description of the radula in Adanson, which with the underlying tongue he regards as a lower jaw. "La mâchoire inférieure," writes Adanson (*Hist. Nat. du Seneg.*, p. 17) in a Bulimus, his *B. Kambeul*, "ne consiste que dans le palais inférieur de la bouche, qu'est tapisé d'une membrane coriace, mais extrêmement mince, blanche et transparente, sur laquelle sont distribués longitudinalement sur deux cens rangs environ vingt mille dents semblables à autant de crochets courbés en arrière. Ces crochets sont si petits qu'on a peine à les sentir au toucher, ou ne les distingue parfaitement qu'au microscope."

Poli was one of the first to figure the radulæ of cephalopods, gastropods and Chiton; then Savigny in his Zoology of the Description de l'Egypte. Cuvier in his Memoires correctly described the radulæ of a number of mollusks, but attached little systematic value to the part. On the other hand, Quoy and Gaimard, and Souleyet in the works describing the collections of their voyages, figured many radulæ, but they were not brought forward with sufficient prominence. In Osler's work on the mode of feeding of mollusks, attention was again more especially directed to the radulæ, and Lebert studied the same more particularly with reference to their microscopic characters. As already observed, the extensive observations of Lovén and Troschel are the most comprehensive in their treatment of the subject of this discussion, though the great work of the latter approaches completion very slowly. We shall hereafter sketch an outline of the classifications which have been wholly or partially based upon modifications of the odontophore.

The tongue, beset with such teeth, is well adapted as an apparatus for filing off or rasping food and drawing it into the mouth. In mollusks which creep up on the glass sides of a vessel in which they are confined, one can easily observe the mechanism of eating. The tongue with the whole oral mass is pushed forward a little beyond the lips, so that one can see the

little teeth spreading out. The tongue rubs off particles of nourishment only in the process of retraction, or tears pieces from leaves for example, and draws them into the oral cavity. In seizing and holding the nourishment, the strong annular lip and the jaws are useful accessories.

As already stated, certain corresponding peculiarities of animals and shells enable us to separate the carnivorous from the phytophagous mollusks; curiously enough, the arrangement of the lingual ribbon does not always indicate this separation, and we accordingly find, in systems of classification based upon this organ, the animal and vegetable feeders rather incongruously mixed.

Besides the mastication of food, the teeth are probably used by the carnivorous species in boring through the shells of other mollusks in order to obtain the flesh. It is still a matter of discussion whether this operation is effected by mechanical or chemical action or by a combination of both; but it is generally supposed that the teeth are the tools by which an excavation through the hard shell of the victim is perforated. Most of the large siphonostomate prosobranchiates obtain food in this manner, as well as the Naticas among the holostomates; and I shall have occasion frequently to refer to the subject hereafter when treating of the individual species. The shells attacked are usually bivalves, which are bored near the beaks where they are thinnest. That instinct is sometimes at fault in these creatures is evidenced by the solid spine of a sea-urchin, which P. P. Carpenter relates, has been bored through by a mollusk.

On every coast the evidence of this work of destruction is abundant, a large portion of the bivalves washed ashore, being perforated near the umbones.

Muller has seen Cerithia on the Brazilian coast bored by *Murex Senegalensis*, in consequence of which the animal dies and opens its operculum, when a Turbinella comes to share the feast. He has seen a dozen specimens of Cerithium at one time with the Murex extracting the meat through a boring in the spire and the Turbinella at work within the aperture of the shell. When both these are done, a Pagurus crab occupies the empty shell, or shares it with a Crepidula.*

Möbius† has seen *Venus mercenaria* and *Cypræa Europæa* bored through the shell by *Murex erinaceus*, and the soft parts eaten.

Mr. C. Spence Bate has proposed the following theory of the means by which mollusks make these perforations.

"His observations upon the boring of the Buccinum into the shells of other mollusca attributed their power of perforation to

* *Jena Zeit.*, 57, 1871. † *Zool. Garten*, 371, 1866.

a current of sea-water passing through the buccal apparatus, the lingual ribbon having no part in the operation. The animal takes two days to perforate the shell of *Mytilus edulis*, and performs the work without the least motion of its shell, as must be the case whenever a circular hole is bored by mechanical action. The sea-water itself is probably the solvent used in boring by the mollusca, being charged with free carbonic acid; and is directed by them against the object to be bored through the process of respiration, and ciliary currents. The action of sea-water upon limestone coasts in driving tunnels and excavating caverns in the rock is evidence of this solvent power; and the same theory will probably account for the absorption of the columella in the Purpuridæ as well as other instances of absorption by the animal of portions of its shell."

I think that the above theory, ingenious as it is, will not account for the perfectly round hole, with clean-cut vertical walls made by boring mollusks in the shells of their prey; indeed it is difficult to imagine any solvent as the unassisted agent in making such a perforation; yet, on examining a shell not entirely bored through, the bottom of the hole is perfectly smooth, showing no marks of mechanical rasping.

The œsophagus, as already stated, opens into the upper posterior end of the mouth. In those mollusks furnished with a proboscis, that portion of the œsophagus which traverses it is much narrowed, and when the proboscis is retracted it is bent into a sigmoid or coil. In its entire length it is provided with interior longitudinal folds. Its middle is dilated into a sort of crop in Voluta, Dolium and some other prosobranchiates. Keferstein has found in *Triton variegatum*, and in *Dolium galea* that the œsophagus, just behind the lingual wall (ix, 96), is dilated below into a longitudinal pouch which is filled up with a gelatinous tough mass, projecting into the interior like a ridge: it consists of a hyaline material, with many spindle-shaped or stellate cells with round nuclei. A similar organ has been detected in species of Murex, Voluta (xv, 82), Ancillaria, etc.

The stomach in its simplest form (xiv, 76), is a dilatation of the digestive tract into which the hepatic ducts open. In Murex and Buccinum it is rounded and curved so that the origins of the œsophagus and intestine approximate. In many of the species a blind sack has been detected in connection with the stomach. In some there are internal lobes or filaments (as in *Mitra episcopalis*), and in others actual tooth-like bodies for compressing the food (Telescopium). In Bythinia, Strombus and Pteroceras the blind sack has been found to contain a firm body, somewhat like the hyaline rod of mussels; it extends some distance into the cavity of the stomach.

The tongue of the Bullidæ being nearly unarmed, an organ

resembling the gizzard of a fowl performs the duty of comminuting the food. It is composed of three calcareous plates (xiv, 73), enormous in relative size in *Scaphander lignarius*, which are strong enough to break the shells of the small mollusks which the animal has swallowed entire. In the Aplysia, which is a vegetable feeder, a number of semicartilaginous plates and spines perform the office of a gizzard. Again, in Cyclostoma, Paludina, Trochus, Strombus, the stomach contains a free chitinous stylet of analagous function, notwithstanding the presence of teeth upon the lingual ribbon.

The intestine in spiral shells may enter the stomach opposite the entrance of the œsophagus, or, in consequence of the bending of the stomach, it most usually enters not far from the œsophagus; it then bends forwards, terminating in an anus situated not far from the respiratory orifice. In the carnivorous species, Murex, Triton, etc., the intestine is short and direct or nearly so, but in the phytophaga it is elongated and usually forms one or more convolutions (xv, 81). In the rhipidoglossate gastropods (Turbo, Trochus, Haliotis) the intestine traverses the heart. The intestine may be distinguished into two portions, the small intestine and the rectum, the latter being usually enlarged in diameter, confined to the anal end and straight portion of the tube, and having longitudinal folds of its inner wall. In the female, the vagina is placed alongside the rectum, and in some univalves there are anal glands opening by the anus.

The anus is simply a round opening closing by sphincter muscles, situated in the anterior part of the respiratory cavity; and therefore lying on the right side of the animal when dextral, or on the left side when its shell is sinistral. In certain nudibranchs it is dorsal, and in some of the naked snails, etc., at the posterior extremity.

Salivary Glands. Usually a pair of these lie along the œsophagus (behind the œsophageal ring), and open into it close to its entrance into the oral mass. These glands may be tubular and long, dilated behind as in Strombus, or the posterior extremity cork-screwed as in Voluta (xv, 82), or they may be short or cylindrical or clavate as in Pleurotoma, Littorina, Trochus, etc. Sometimes, as in Dolium, Cassis and Triton, the elongated glands are in two subdivisions, divided by a deep fissure into a small anterior and a larger posterior portion (ix, 96). The two glands may also unite over the dorsal side of the œsophagus, into a single mass, from which, however, separate ducts proceed on either side. When two pairs of salivary glands exist, as in Janthina, the anterior pair open near the buccal orifice.

Souleyet was not able to discover distinct salivary glands in Turbo, but its œsophagus is enlarged just behind the mouth, and

this enlarged space is furnished with a number of folds which may be regarded as substitutes.

In Conus there is only a single gland (xv, 80), and it is very doubtful whether this is salivary in function: Troschel considers it a poison-gland.

In addition to the salivary glands there is found in Murex (not observed in other genera), a gland lying above the œsophagus; it is thick, granular in structure, of liver-brown color, divided into several large lobes and opens into the œsophagus by two ducts. Its purpose is unknown. In Dolium, the glands are enormous, each consisting of two enlarged portions, the anterior one compact and secreting the saliva, the posterior much larger, membranous, and the secretion of which is distinctly acid, a property first detected by Troschel, and afterwards observed in this and in several other mollusks by a number of investigators.* Troschel states that if the *Dolium galea* is irritated, it will protract its proboscis as much as a foot, and eject from it a quantity of clear fluid, with a very acid smell, and producing effervescence upon calcareous soil. The liquid has been ascertained to contain several per cent. of free sulphuric acid, and about 4 per cent. of hydrochloric acid.† How the mollusk secretes this acid, and how it protects its own tissues and the epithelial cells of the glands themselves against its action is not at all understood. The acid secretion does not appear to be taken into the stomach, for Troschel found in the stomach of Dolium seaweed and calcareous remains, which, when artificially brought into contact with the acid, immediately commenced to dissolve. He thinks the secretion is for defensive purposes, and it has been suggested by others that it assists carnivorous mollusks like the Murex in boring into the shells of their victims—usually bivalve mollusca.

The liver is a brownish or greenish gland of extraordinary size, which forms almost the whole of the usually spirally coiled hinder portion of the animal from the stomach back, giving up to the sex-glands but a small space. The form of the liver is, therefore, very much the same as that of the posterior portion of the body itself. It is lobulate, and when removed to water is found to be acinose. The acini at their ends are cleft into many digitiform processes; the ducts from the acini unite, then those of the lobes, with frequently sinus-like dilatations, but ending as two bile ducts, placed one before the other, and which correspond to the largest subdivisions of the liver, and approach and, finally, enter the

* *Researches upon the organs which, in the gasteropods, secrete sulphuric acid.* By Prof. Paolo Panceri, *Jour. de Conch.*, 3d ser., ix, 308, 1869.

† De Luca and Panceri have ascertained the existence of free sulphuric acid in the salivary product of Murex trunculus and M. brandaris. *Ann. Sc. Nat.*, 87, 1867.

digestive tract at the stomach; if a blind sack is present they enter in front of it.

One may accordingly regard the liver as a much subdivided gland, since it is only at a few places, in respect to minute structure, that its ducts and sinuses may be distinguished from the terminal lobes. The liver consists here, as in all univalve mollusks, of an outer structureless membrane and an internal epithelium of roundish secretive cells, which have a distinct nucleus and yellow concretions, and also contain fat. H. Meckel would distinguish fat and bile cells; according to Leydig, however, there is no such distinction possible. The hepatic lobules are united together by thin membrane, plexuses of finely subdivided blood-vessels surround them, and externally the whole liver is surrounded by a blood sinus.

In the nudibranchiates (xiv, 72), the stomach is remarkably branched, its ramifications even entering the dorsal respiratory papillæ in the Eolids. These ramifications have glandular walls which secrete bile and may therefore be considered a singular sort of liver. Although the intestine is functionally replaced by this anatomical disposition, it still exists in the form of a very short tube opening on the right side of the body. The interpretation of the gastro-hepatic organ of the Eolidians has given rise to much discussion. Quatrefages proposed for the Eolis and Elysia the name of Phlebenterata, and supposed that the product of digestion (chyle) was aerated in the gastric ramifications by the direct influence of the surrounding water. In the former he admitted a heart and arteries but no veins, in the latter he supposed both heart and blood-vessels to be wanting (*phlebs*, a vein; *entera*, the intestines). He denied an anus to the digestive tube, and thus gave to the hepatic cæca the offices of both digestion and circulation. The fallacy of all this has been shown by Souleyet, who has demonstrated the existence of heart, veins and anus in the Eolidians. The *kidney* or *renal organ* is single in all gastropods (paired in the Scaphopoda and lamellibranchiates), and placed in the vicinity of the heart. It is represented by the *Bojanus organ* of the bivalves.

The kidney is a large, hollow, glandular mass at the base of the respiratory cavity, close to or sometimes perforated (Triton) by the rectum. It contains a fluid having a whitish or brownish appearance, filled with hard granules, and in which Jacobson first detected the presence of uric acid, ammoniac and salts of lime.

If the kidney is cut open the internal cavity is observed, which is, however, much narrowed by numerous thick, spongy, crimped annular folds or meshes, which clothe it internally. The spongy walls, the surface of which, because of the folds is much increased, are covered with round cells, which excrete the urinary products. At the wall of the cells, at least in the youngest ones, there is

always a distinct nucleus and its contents consist sometimes of a yellowish or greenish fluid, and within are concentrically laminated urinary concretions. By bursting, these secretory cells allow the urinary concretions to escape into the water in the kidney.

Externally, the kidney is spun over by a very thick and strong vascular network of the venous system. This vascular network has several openings into the kidney, through which the urinary products are mingled with the blood; and, consequently, when these are examined microscopically, they are found to contain, besides renal cells and free concretions, a considerable number of blood-corpuscles.

Usually the kidney opens into the base of the respiratory cavity by means of a transverse, slit-like opening, encircled by a strong sphincter muscle Triton, Dolium, Cassis, Murex, Littorina, Natica, etc.); sometimes, however, it has a gut-like, efferent duct, a ureter, which passes forward between the rectum and sexual canal, opening outwards not far behind the anus (Paludina, Turbo, Voluta, Conus). There are accordingly three efferent canals alongside of each other at the right side of the respiratory cavity, viz., the rectum, ureter, vagina or vas deferens. The ureter is usually a somewhat dilated canal and is not simply a prolongation of the kidney, but is often separated from the latter by a diaphragm perforated by a number of holes which are encircled by muscular fibres. Within, a number of longitudinal folds are to be observed, and it is covered throughout with ciliated epithelium. The ureter is usually filled with water and it is possible that it may have some other significance than a mere efferent duct.

Pteropoda. This little group of pelagic animals are much simpler in organization than the gastropods, and to a certain extent may be comparable to the larval stage of some of the latter. Their entire life being passed in the open sea, far from any shelter save that of floating weed, they are active in habit, swimming by the vigorous flapping of their natatory lobes, and, as might be expected, small and fragile as they are, are carnivorous. Clio and Pneumodermon constitute the section Gymnosomata, in which the head is distinct and the animal is without shell; these are provided with tentacles, the surface garnished with suckers, and well adapted for seizing their microscopic prey. There is also a lingual ribbon, well studded with teeth, and two jaws, each consisting of an agglomeration of corneous spines. But the Pneumodermon possesses an additional and very curious prehensile organ which recalls the tentacular arms of the decapod Cephalopoda; in two long caeca placed at the posterior part of the pharynx are lodged cylinders covered with recurved spinules, and which like the proboscis of certain gastropods, the animal

has the power of protracting and retracting at pleasure. In the Thecosomata, those pteropods having a shell, the head is indistinct and tentacles rudimentary, and the mouth is situated in a cavity formed by the union of the two fins. There are two corneous jaws and a lingual ribbon.

In all pteropods the rest of the digestive apparatus is similar and simple in structure. There is a pair of salivary glands; the membranously walled stomach is encircled by the liver which adheres and opens into it by several orifices; * the short intestine opens by an anus on the right side of the body. The kidney is represented by a contractile sac communicating on the one side with the sinus of the pericardium, and on the other with the exterior. It does not appear to be secretory in function, its principal object being the introduction of water to the pericardium.

Scaphopoda (xiv, 71; iii, 43). The Dentaliidæ are animal feeders, devouring foraminifera. They have no specialized head, but the mouth is surrounded by several labial palpi, and at its base are numerous very extensible filaments, covered by vibratile cilia, and terminated by a sucker. There is also a lingual ribbon. The intestine is short, and the rectum traverses the sanguineous pocket which represents the heart. The kidneys are paired, opening on the right and left of the anus.

Pelecypoda or *Lamellibranchiata* (xiv, 75). The digestive organs are much more simplified in the bivalve shell-fish than in the Gastropoda. The *mouth* is at the anterior part of the body between two pairs of *labial palpi* (ix, 100; iii, 50, 52), appearing like accessory branchiæ and striated upon one face. These lips are equal in dimension, triangular, and varying much in size in the different genera; in Tellina even as large as the branchiæ, although they are generally much smaller. Mostly simple in outline, those of the Pectinidæ are arborescently lobulated. No apparatus exists in connection with the mouth for the comminution of the food, neither tongue, jaws nor muscular pharynx; salivary glands are also wanting. From the mouth a short œsophagus opens into the stomach, and the long intestine, which is usually much convoluted, is terminated by a rectum opening above the posterior adductor muscle (xxii, 65). Mr. Ryder † finds the intestine in the American oyster, to have but one complete turn upon itself, and in the course of its (dorsal) flexure, to pass almost directly over the mouth, and to be provided with a pair of internal longitudinal folds. Except in Ostrea, Teredo, etc., the rectum traverses the ventricle of the

* In Hyalæa there is a crop and gizzard armed with corneous plates; the liver is not adherent.

† Am. Naturalist, 674, 1880.

heart The liver embraces the stomach and a portion of the intestine, its acini forming numerous lobules which open by orifices into the former, and the anterior portion of the latter. There is usually a blind sac; sometimes, as in Pholas, Tellina, etc., very long, and extending between the circumvolutions of the intestine. Within this is generally lodged a transparent, cylindrical, cartilaginous body called the crystalline stylet, which is sometimes present, sometimes absent in the same species, from which Siebold infers that its appearance is periodical. It is probably an accessory digestive organ; but appears to be absent in some of the Monomyaria. In the Unionidæ the stylet is found in the intestine (it is over half an inch long in *U. cariosus*), and the blind sac is not developed. Those Pelecypoda having a closed mantle receive through the incurrent siphonal tube such microscopic food as may accompany the water inhaled for breathing; in others the water has free access to the gills; and in both cases the ciliated laminæ of these organs arrest floating particles of food and mould them into threads by a viscid secretion of the surface; they are then propelled in the direction of the mouth, which they enter between the palpi. Minute vegetable organisms and animalcules are found in great abundance and variety in the stomachs of bivalve shell-fish.

The renal organs are paired, and have received, after the name of their discoverer, the appellation of *Organs of Bojanus*. They consist of symmetrical glands, at the base of the branchiæ, in the dorsal region. The excretory canals of these glands open, in Mactra, Unio, etc., contiguous to that of the genital organs; in Arca and Pinna they unite with the oviducts; in the Pectinidæ the genital glands pour their products directly into the Organs of Bojanus. In the Unionidæ, Cardium, Pholas, etc., Lacaze-Duthiers has found another orifice by which this organ communicates with the pericardium. The organs of Bojanus are brownish or greenish yellow, spongy, and secrete uric acid, with concretions of carbonate of lime.

ORGANS OF SECRETION.

Besides the salivary and urinary organs described in connection with the chapter on the digestive system, there exist in some mollusks special organs, the products of which are sufficiently important in character to require particular description. The first of these is the Ink-gland of the Cephalopoda.

The ink-bag or anal gland (ix, 93), (not present in Nautilus), is a tough and fibrous sack, the outer coat of which is thin and silvery; the contents are discharged by a duct direct (or, as in most decapods, through the anus) into the mantle opening, and thence diffused in the surrounding water; covering the movements of the animal by the obscurity in which it becomes almost

instantly enveloped. There can be no doubt of the use of this organ in facilitating escape from danger. The ink itself was formerly used by the Chinese in the preparation of sepia or India ink, but this substance is now made from lampblack. The method of preparing sepia practiced on the shores of the Mediterranean, is to carefully extract the ink-bag and dry its contents. Triturated with caustic soda or potash, it is afterwards boiled for half an hour with caustic lye, and finally the liquid is treated with an acid until neutralized. After standing, a precipitate falls, which is collected and dried by a mild heat, and forms the sepia of commerce. So indestructible is the ink, that it is frequently met with preserved with the fossil remains of Belemnites and other extinct genera. The full protection afforded the soft parts by the external shell of the tetrabranchiates accounts for the absence of the ink-bag in that division of the cephalopoda.

An analysis of sepia shows that 78 per centum is composed of the black coloring matter (the Melania of Bizio), and that of the residuum there is 10 per centum carbonate of lime, 7 per centum carbonate of magnesia, and sulphate and chloride of soda 2 per centum.

"Mr. Lloyd states, in his interesting 'Handbook to the Marine Aquarium,' that the ink (which is viscid) does not generally become diffused through the water as writing-ink would be, but is suspended in the water in a kind of compact cloud till it gradually settles down, and is dispersed in flakes. Now I quite think, with Mr. Lloyd, that this being the case, it is difficult to perceive how, according to the generally received opinion, the retreat of the animal is covered by the ejected cloud. It seems to me more likely that this discharge is to divert the attention of a pursuer—a dog-fish for instance—which would for the moment be startled by the sudden appearance of masses of dark color in the water, and in the confusion the cuttle makes his escape."—W. R. Hughes, in *Nature*, ix, 363, 1874.

Purple Gland (xv, 79). This gland accompanies or is a modification of the mucus-gland. It is only found in a portion of the prosobranchiate gastropods; among them, in both the typical Muricidæ and the Purpuridæ; but a similar gland secretes a violet liquid in Janthina and Aplysia, and yellow in the Bullidæ. The peculiarity of the fluid secreted by this gland is, that originally colorless or yellowish, a short exposure to sunlight changes it to a brilliant violet or reddish color, at the same time giving off a very penetrating fetid odor.* The cause of this photographic change of color is unknown, but the knowledge of it came to mankind in very early ages, and Tyrian purple was

* It is colored at the moment of its secretion in Aplysia.

the most highly prized and most beautiful dye known to the ancients.*

Pliny states that in his time the purple dye was obtained from the Buccinum and the Purpura. The mollusk now known as *Murex trunculus* is generally supposed to have been that principally used by the ancients in obtaining the Tyrian purple. It is related that the discovery of the dye is due to the dog of a Tyrian nymph, which crushing some of these shells in its teeth, its mouth became stained with purple. It is possible that the fragile Ianthina may have been thus crushed, but the shells of the Muricidæ would resist the dog's teeth. To be exact, this event occurred 1500 B. C. The color was so beautiful that the fair nymph expressed to her lover, Hercules, her desire to have a robe of similar hue. Hercules, of course, gratified her. It is evident that the product of two different species was mixed in order to produce the finest color, as Pliny gives the proportion of 200 pounds of juice of "Buccinum," and 111 pounds of that of "Pelagia" as suitable for obtaining a beautiful amethyst color, sufficient for 50 pounds of wool. The extent of the Tyrian industry is visible in numerous holes in the rocks, two to three feet deep, containing the breccia of shells anciently crushed in them for the extraction of the dye. The arms of the city as preserved on its medals was the purpura shell, and in the time of Strabo the multiplicity of dye-works unpleasantly affected the air of the vicinity. The Romans used various species in great quantity for dyeing purposes, and the remains of Murices form vast heaps; indeed in one case, at Tarento, the mass is so large as to have received the name of "Monte Testaceo."

The color was prepared by pounding up small specimens, or by breaking the shells of larger ones and extracting the purple gland. This fluid was mixed with five or six times its weight of water, with twenty ounces of soda to every hundred pounds. Placed in lead or tin vessels the mixture was exposed to the sun for several days, until the hue desired was obtained, when the wool was simply plunged into it and allowed to remain for a few hours. Under Augustus the dyed wool brought as much as $200 per pound.

The Indians of the new world also understood the art of purple dyeing from shell-fish, and it is probable that all ancient peoples inhabiting sea-shores have become accidentally acquainted with this property, common to so many mollusks, at a very early

* See Lacaze Duthiers' (*Ann. Sc, Nat.*, xii, 5, 1859) exhaustive "Mémoire sur la Pourpre," an exceedingly interesting paper, illustrated by specimens of the color resulting from various applications of the dyes obtained from Murices, Purpuras, etc. See also *Smithsonian Report*, 1863; *Lovell's Edible Mollusks*, p. 124; *Grimaud de Caux, Rec. et Mag. Zool.*, 34, 1856.

date. The Roman law prohibiting the use of purple garments to any but the imperial family, was a deathblow to this industry, which thenceforth rapidly declined. During the middle ages the very existence of such a dye was considered fabulous; but with the revival of the arts and civilization its properties were rediscovered, and for awhile successfully utilized. Chemistry has now supplied us with even more brilliant colors, whilst saving much of the cost of procuring material.

An anal gland accompanies the purple gland in Murex and Purpura and has not been discovered in other mollusks. It lies on the left side of the rectum and consists of a central canal with lateral branches having a dendritic appearance. It opens on the edge of the anus, and by pressure its brownish contents may be made to issue. The function of this, as well as of the purple gland is unknown.

The Mucus-Gland lies in the middle portion of the cover of the respiratory cavity in most prosobranchiates; its tough secretion is discharged through the respiratory opening in extraordinary quantity, especially when the animal is handled.

The glands of the mantle-border of Oncidiella are remarkable for their size and the regularity of their position. They all open at the summit of little cutaneous eminences, and they secrete an abundant whitish liquid.

Mucous glands are largely developed in the *pulmonata geophila* or terrestrial pulmonates. There exist in Limax, Helix, etc., a series of unicellular glandules the contents of which are poured into a large canal which opens on the anterior part of the body between the head and foot. This organ was discovered by Kleeburg, after whom it is named. Its functions have been variously interpreted, and Leidy has thought *Kleeburg's Sinus* an olfactory cavity.

In Arion, Helicarion, Parmarion, Nanina, etc., there is a mucous gland opening by an orifice (*mucous pore*) at the dorsal posterior extremity of the foot: its product is very abundant.

Many gastropods and bivalves secrete a glutinous thread, strong enough to support the weight of their body. Thus the young of certain limaces descend from one branch to another, suspended by a filament adhering to their tail. *Chondropoma dentatum* produces a filament which passes between the operculum and the wall of the shell, by which the animal suspends itself to branches or leaves. Numerous filaments fix in like manner the Cerithidea to brackish-water plants. The fresh-water univalves Physa, Limnæa, Planorbis, Neritina and Bithynia, and the bivalve genus Sphærium, suspend themselves in the water in like manner; Rissoa, Odostomia, Eulima, Cerithium are examples of marine mollusks possessing a like faculty. Litiopa, a small gastropod, lives abundantly in the floating fuci and

sargassums, suspended by one or several filaments. If these cords be broken, the mollusk emits an air-bubble enveloped by a glutinous substance which rises to the surface of the water, carrying with it the end of a new filament: upon coming in contact with the fucus a new attachment is formed.

The Ianthina constructs a floating apparatus or raft (xvii, 99), attached to its foot and comprised of a quantity of airy vesicles. Lacaze-Duthiers states that upon detaching the float the animal sinks; but that the groove of the foot imprisons some air-bubbles under a glutinous envelope, by the aid of which it again seeks and maintains itself upon the surface of the water until a new raft is developed.

Many of the lamellibranchiates secrete a byssus. Its gland is situated in a groove towards the base of the foot, on its ventral surface. It produces a number of elastic, adhesive filaments by the aid of which the animal attaches itself to submarine bodies (iii, 41). In Tridacna, Avicula and Arca the filaments cohere, forming a homogeneous mass; in Pinna the fibres are distinct, fine, numerous, silky, and capable of being woven, so that gloves have been made from this material. In Mytilus the filaments are frequently separated at the attached end so as to occupy several points of anchorage (iii, 40).

Many embryonic Unionidæ are known to possess a byssus, and a few adult species also have it; in *Unio acutissimus* it is over an inch in length (Lea). By means of its byssus a bivalve mollusk is able to ascend perpendicular surfaces. It abandons at will the various threads it has woven, and also breaks those which impede its movements. The activity of the byssal gland of *Pecten varius* is such that Fischer has observed at Arcachon, an individual secrete sixty byssal bundles in eight days, during which time it had elevated itself on the aquarium glass to a height of about two feet—each abandoned byssus being attached about ·4 inch below its successor.

The byssal plug of Anomia is the calcareous product of a gland replacing the byssal gland; morphologically it is a calcified byssus.

SEXUAL ORGANS.

There is much diversity in the reproductive organs of mollusks, and in some of them the whole history of reproduction is fraught with so much interest that I deem it advisable to devote a few pages to the subject. The reproduction of mollusks is in all cases effected by means of eggs. In a few gastropods the young are hatched and retained for a period within the oviducts of the parent—such ovoviviparous species are Paludina, Cymba, etc.; the eggs of the acephala also sometimes remain within the parent shell until hatched.

In the Cephalopoda and the prosobranchiate gastropods the sexes are distinct (diœcious), but they are united in the same individual in most of the other mollusks (monœcious). The Cephalopoda and prosobranchiates pair, the monœcious land snails require reciprocal union; the limneids unite in succession, forming floating chains; in the lamellibranchiates the spermatozoa are discharged into the water, whence they are inhaled with the respiratory currents.

Cephalopoda (xvi, 84–87, 90, 92). The sexes are distinct, and in some of the genera at least, the female individual is the largest and readily distinguishable externally.* The reproductive organs are lamellar or branched; their cellular contents are metamorphosed into *ova* or *spermatozoa*, which are attached to the wall of a chamber communicating with the pallial cavity by one or two ducts, which, in the female present glandular enlargements. Upon the walls of the branchial cavity of the female two *nidimental glands* are developed; besides, sometimes accessory glands, within which is secreted a viscid fluid which envelops the ova and aggregates them into various forms, differing according to the genus.

In the male the cases or *spermatophores* (xvi, 92), containing the spermatozoa are furnished by a prostatic gland. These spermatophores, in the dibranchiata are ovate, cylindrical and narrow, consisting of a thin case, ending sometimes in a filament at one end; at the other or thicker end is contained a sack full of spermatozoa, to which is attached an elastic spiral cord, coiled and compressed within the balance of the case. Upon coming in contact with the water these spiral bodies commence moving and finally burst through the thin end of the investing spermatophores dragging with them their sacks of spermatozoa.

In Nautilus, Van der Hoeven has ascertained that the structure of the spermatophores is much more simple. In this genus the oviduct arises from a chamber which communicates with that in which the ovary is lodged. A large albumen-gland opens into the latter. So also the *vas deferens*, instead of originating directly from the sack of the testes, communicates with it through an intervening chamber.

The most curious portion of the sexual history of the dibran-

* The sexes in *Sepia officinalis* may be readily externally distinguished. There is in the first place a difference of coloration, the females being unicolored, whilst the males have zebra-like markings across the marginal fins and the dorsal arms—especially when irritated. But the best means of distinction is in the relative lengths of head with the arms and body; in the males these two dimensions are about equal, but in the females the body is only two thirds the length of the head and arms. The cuttle bone in the female is much wider and more excavated behind.—BERT, *Mem. Linn. Soc. Bordeaux*, v, 118.

chiate Cephalopoda is undoubtedly that which relates to their sexual union, accomplished through the offices of one of the arms of the male, which becomes modified in its structure for this purpose. This arm, very unlike the others in appearance, sometimes becomes detached from the animal during the sexual union, and remains within the mantle of the female for a period, during which it enjoys a separate life. Each genus seems to be characterized, not only by the particular arm, either on the right or left side of the animal which is thus *hectocotylized* but also by differences in its appearance and structure. The third left-side arm of the Argonaut is first developed as a balloon-shaped sack, which finally splits open and reunites its halves upon the dorsal face of the arm which emerges from it, forming a chamber which becomes filled with spermatophores, in a manner not yet understood. Indeed the investigation of this whole subject may be considered as yet in its infancy, and many points remain to be cleared up: thus in some genera no sack for the reception of spermatophores has been found, and the hectocotylized arm appears to perform its office without subsequent detachment from the animal, merely inserting itself within its own mantle to gather spermatophores, which it proceeds to deposit upon the buccal membrane of the female. The detached hectocotyle when first discovered in the mantle of the female was naturally regarded as a parasitic worm; that of Argonauta being termed *Trichocephalus acetabularis* by Chiaje and that of Octopus *Hectocotylus octopodis* by Cuvier. More recently it was supposed to be the entire male animal of the cephalopod.

The specialization of an arm for reproductive purposes in the Cephalopoda is curiously paralleled in the arachnida, as in some species of spiders certain parts of the palpi of the males are transformed for the same purpose into spoon-shaped organs. As to the loss of the hectocotylized arm, which at least occurs usually in some genera, as *four* of them had been discovered in the mantle opening of a single female Octopus, there is no doubt that another arm is developed to take its place, and it is probable that these succeeding arms may be hectocotylized like the first.

In Tremoctopus the third arm on the right side becomes hectocotylized; it is then worm-like in appearance, with two rows of suckers on its ventral surface and an oval appendage at the posterior end. The anterior part of the back is fringed with a double series of branchial filaments (250 on each side). Between the filaments are two rows of brown or violet spots. The suckers (forty on each side) closely resemble, but are much smaller than those of the normal arms. Between the suckers are four or five series of pores, the openings of minute canals passing into the interior. There is an artery and vein on each side, giving branches to the branchial filaments, while a nerve

runs down the centre. The *oval sack* encloses a small but very long convoluted tube, ending in a muscular sack which contains the spermatozoa.

The hectocotyle of the Argonaut is very small, only half an inch, with a filiform appendage in front of about equal length; it has two rows of alternate suckers, forty-five on either side; but no branchiæ.

In Octopus the hectocotylized arm instead of being much shorter than the others, as in Argonauta, becomes much longer. It terminates in an oval plate, marked with numerous transverse ridges and intervening pits, and this is connected by a muscular fold of skin running along the dorsal face of the arm with the webbed base covering a passage through which the spermatophores are probably transmitted to the terminal plate.

It has already been shown that in the male Nautilus the four inner ventral tentacles become united into a so-called *Spadix;* this is now believed to perform in the tetrabranchiates the sexual office.

M. Steenstrup remarks that it is evident this peculiar structure, sometimes of one pair of arms, sometimes of another, sometimes to the right, sometimes to the left, sometimes at the summit, sometimes at the base, etc., must involve many differences in the mode of fixation of the spermatic masses or spermatophores on the females, and (inasmuch as the semen does not seem to be poured upon the eggs by involuntary or mechanical, but by conscious movements) in the manner in which fecundation is effected. This is confirmed by observation. The spermatic masses are in reality fixed on very different places and in very different conditions—namely, in the genera Sepia, Sepioteuthis and Loligo (consequently all those in which he has found the left ventral arm hectocotylized) the spermatic mass is fixed on the internal surface of the buccal membrane of the females, which is specially organized for that purpose; whilst in the other decapoda he has never found the sperms fixed in that place, but on various parts of the mantle or of the interior organs, in Ommastrephes, for example, far back in the cavity of the mantle, towards the middle part of the back.

In the "Actes de la Société Linnéenne," of Bordeaux, 1872, M. Lafont states that a *Sepia Fillioaxi* deposited its eggs in one of the basins of Arcachon, on the 23d of May, 1870, attaching them to a Zostera (xviii, 13–14.) Taking it from the water, he found all around the mouth, attached by the large end, a certain number of little sacs filled with spermatozoa. Replaced in the water, the animal continued to oviposit. In again examining it, at the end of about a half-hour, he saw that the number of sperm-sacks had diminished, not more than a dozen remaining. As soon as again put in the water, a male approached and a

sexual union took place. He immediately examined the female again, and found the mouth surrounded by spermatophores attached to the buccal membrane. After this examination, the animal was permitted to continue ovipositing, which she did for more than two hours. It is evident, says M. Lafont, that these spermatophores serve to fecundate the eggs at the moment when they pass out of the siphon and when the female takes them between her arms. Since that period more than half of the females of Sepia and nearly all those of Loligo that he has examined, were found to carry a greater or less quantity of spermatophores around their mouth.

Steenstrup has shown (*Ann. Mag. Nat. Hist.*, 2 ser., xx, 1857) that whilst the octopods (which alone are known to lose their copulatory arm) possess in the highest degree the power to reproduce mutilated members; the decapods, on the contrary, are not able to remedy such losses by a new growth; and this is a cogent reason for believing that the process of fecundation is entirely different in the two groups. Steenstrup states that the hectocotylized arms, so far as he can ascertain, present no changes at the season of copulation, that they present the same features in small as in large individuals; and he assumes that when the young male leaves the egg it is already furnished with the hectocotylized arm proper to its species.

Braun has supposed the aptychi to be the shells of the males of Ammonites, instead of opercula; thus he explains why they are so often found at the base of the first chamber of Ammonites. The opinion has more recently been advanced that the aptychi were protective organs of the nidimentary glands of female Ammonites.

M. Ussow observes that the spawning time of Argonauta lasts from May to August; of Loligo, Sepiola and Ommastrephes, from March to June; but he has obtained mature ova of Sepia in Naples almost all the year round, except in August.' —Ussow, "Development of Cephalopoda," *Ann. Mag. N. H.*, 4 ser., xv, 1875.

I have figured a few forms of egg-clusters (xviii, 12–15): unfortunately the eggs of the Nautilus are not known, so that our knowledge is confined to the dibranchiates. Of these the most curious is the Argonaut, the elegant shelly structure of which originates, as we have seen, from the expanded dorsal arms of the female which cover its sides and form the only attachment of the animal to it. In the unoccupied hollow of the spire are attached the minute clustered eggs (xviii, 15), and its special function appears to be for their protection during development. Each egg is separately enclosed in a rounded shell, which is furnished with a long, thin membrane of attachment. We know but little of the eggs of Octopus: Aristotle describes them as

similar to those of Argonauta, and attached within shells or similar concave surfaces.

In Sepia each egg is enveloped in a large, spindle-formed black capsule, many of which, forming a close mass, are attached to some marine body.

Another form of egg-masses is that in which a number of eggs are contained in a single large capsule (of which many are aggregated into a mass), attached by its pedicel to some submarine object. In *Loligo vulgaris*, for example, each long bag-like capsule contains thirty to forty eggs. The capsule of Sepioteuthis is similar, but shorter, and contains fewer eggs.

During the summer of 1876 I resided at Atlantic City, on the New Jersey coast, and then enjoyed frequent opportunities for observing the development of *Loligo punctata*, De Kay (xviii, 12); masses of egg-capsules of this species being thrown upon the beach in considerable quantity throughout the season. Some of these masses, when the embryos had attained considerable growth, had grown to prodigious size and weight, being several times larger than the animal which deposited them. I have seen hundreds of cylindrical cases, each three to four inches long and half an inch in diameter, composing a single, soft, jelly-like mass, which lay quivering on the beach, reflecting from its glistening surface rainbow hues, and filled with almost innumerable, rapidly pulsating embryos; say, at least 250 to each sack. The details of their form and the colored spots of their body were distinctly visible to the naked eye. Each embryo is enclosed in its separate round, transparent egg-case, and during its development the yolk-bag is attached to its mouth, and surrounded by its arms.

Cuthbert Collingwood (*Jour. Linn. Soc.*, xi, 1873), encountered (in 1870), floating upon the surface of the Atlantic Ocean, in lat. 37° N. and long. 28° W., a gelatinous object, somewhat cylindrical in form, about two feet long and four or five inches in diameter, and containing cephalopodous ova arranged in clusters and single rows. The young animals were very active, and in fact were all discharged a short time after the nidus had been secured. It is impossible to ascertain positively at present to which genus this curious form belongs, though evidently the animal is finned and pelagic. The whole oviposit is here united within a single gelatinous covering instead of being aggregated into sausage-shaped masses each filled with embryos as in Loligo, or in separate eggs as in Sepia. A similar floating mass was obtained by Dr. H. Grenacher, at the Cape Verd Islands, in January, 1872; it was nearly 2·5 feet long by 6 inches in diameter (*Zeit. Wiss. Zool.*, xxiv, 1874).

Quoy and Gaimard (*Ann. Sc. Nat.*, xx, 1830) discovered near the Moluccas, a cylindrical nidimental mass, three feet long and six to eight inches diameter, composed of cephalopodous eggs

placed in double rows on a ribbon, the circumvolutions of which with margins overlapping, formed the cylindrical shape.

Gasteropoda. Prosobranchiates, etc. The sexes are distinct in the prosobranchiates; the organs are, however, very simple and so alike in structure, that frequently the sex of the gland can only be determined by microscopical examination. Usually a germ-secreting gland is imbedded in the liver, from which an efferent duct opens at the right side into the mantle-cavity. In most cases the males may be readily distinguished by the large penis, which is placed at the right side of the head behind the eyes. In Patella, Haliotis, Hipponyx and Trochus there is no copulatory organ. Their genital gland opens in the neighborhood of the anus. Latreille has proposed the name *Agama* for gastropod mollusks without copulatory organs; the others are distinguished as *Exophallia* by Mörch. The shell in the female is generally more inflated than in the male.

Female Organs (xvi. 89). The ovary discharges into a much looped oviduct, and the latter dilates into a gut-like uterus—the last portion of which on account of its muscular wall may be regarded as a vagina. There is sometimes at the commencement of the uterus, or at its connection with the vagina, a seminal pouch, but other appendicular organs are seldom present.

The last portion of the uterus or even the whole of it, and the vagina lie in the respiratory cavity, to the left by the side of the rectum and nearest to the abdominal wall. The sexual opening is accordingly found to the left of the anus, but usually far behind it. Sometimes the uterus is split through its entire length and its folds formed by the longitudinal and transverse plaits, consequently lie freely exposed in the respiratory cavity. Lacaze-Duthiers has so described it in Vermetus.

There is scarcely anything to be said in regard to the eggs of the prosobranchiates, generally. Where their development can be seen, a distinct germinal vesicle and germinative dot are present; but when they leave the ovarium the yolk granules are present in such numbers as to conceal this structure. In the oviduct, or quite above the uterus, the eggs come into contact with the zoosperms, which are occasionally retained at this point in a spermatheca. Further down in the uterus fertilization could no longer be effected as they here become enclosed in a tough albumen, and finally are covered, usually many together with a firm capsule. These egg-capsules, in their various shapes, will be described presently.

Male Organs (xvi. 91). These are simpler than those of the female; the efferent canal is not divided into so many succeeding portions, but instead a copulatory organ (*penis*) is placed anteriorly, the structural peculiarities of which present much that is noteworthy.

The sperm-gland or testicle lies imbedded in the liver in the same way as the ovarium usually, only on the right side, as a flocky mass which has a greater tendency to embrace the liver than to crowd it away. Sometimes, however, it is a compact mass, and in Paludina it is divided into but two lobes, a larger anterior and a smaller posterior one. But in most cases the testicle is a much expanded and divided, flocky-looking, whitish mass, which like the ovarium presents an acinose structure. The efferent ducts of the simple lobes and lobules then collect together on the right side of the body into the vas deferens.

The single testicular lobules consist of a structureless tunica propria and an internal epithelium of rounded cells, in which the zoösperms are developed. In all cases where the mode of development can be followed, the contents of the epithelial cells divide into daughter-cells, in which, after the development and growth of a nucleus and the disappearance of the cell-wall, the spermatozoa are developed. The zoösperms are filiform and pointed at both ends in the spiral prosobranchs, but in Patella, Chiton and Haliotis the anterior end is a rounded head.

The vas deferens passes from the testicle along the columellar side of the animal into the mantle-cavity, and through the latter into the penis on the right side of the body, behind the eyes. This duct is formed externally by a strong muscular layer, and clothed within with a ciliated epithelium: it is usually dilated and coiled at its commencement.

In Paludina a part of the penis is lodged in the teguments of the right tentacle, which in consequence is sensibly deformed and shorter and more obtuse than the right tentacle of the female. In an Indian species of Paludina the penis is altogether aborted and its function transferred to the contiguous right tentacle, the extremity of which is hooked; which becomes a copulatory organ, analogous to the hectocotylized arm of the cephalopods (Wood-Mason, Ann. Mag. Nat. Hist., viii, 87, 1881).

The penis is an outgrowth from the body-wall, and is not evertible and retractile in the prosobranchiates as in the pulmonates, though having at times a cavity within. It is a fleshy, often very long and thick appendage usually bent in a sigmoid form, and can be bent back under the mantle and thus be hidden.

The penis is either hollow, in which case the vas deferens proceeds to it as a closed canal passing through it to its extremity, where it opens upon a small papilla as in Buccinum, or it opens simply as in Littorina, Oliva, Oncidiopsis; or, in other cases it is a solid body upon which the vas deferens passes along in the form of a ciliated furrow continued upon it as a deep groove to its extremity, as in Triton, Dolium, Cassis, Harpa, Voluta, Terebra, Strombus, Cypræa, etc. This last and most common form of penis presents many varieties; in Cassis, for example, it

is pointed anteriorly, in Dolium it is enlarged anteriorly, in certain species of Strombus it has a small appendage upon the posterior side, and in Natica it presents at the end a whip-like (flagelliform), in Dolium a claw-like appendage. Usually there are large sack-like glands, which are placed on large pointed papillæ near the base of the penis; they appear therefore as a row of tubercles or processes, as in Littorina, Cassis, and Terebra: these glands are placed upon special finger-like outgrowths of the penis.

The copulatory act usually takes place in the spring; but in Littorina it occurs throughout the season, and the female has sometimes both large and minute eggs in her uterus.

The eggs come in contact with the spermatozoa and are fertilized in the oviduct or at the commencement of the uterus. The eggs consist of a dark granular yolk; a germinal vesicle and one or more germinative dots, enveloped by a thin vitelline membrane. The zoösperms penetrate this membrane through an opening termed the micropyle. They are introduced into the female tract by an act of copulation in the bulk of the spiral prosobranchs, which possess a penis; in the Trochoidea, Scutibranchs and Cyclobranchs, however, the copulatory organ is wanting, and probably the spermatozoa discharged into the surrounding water by the male, are thence taken into the uterus. Of course the *attached* genera like Vermetus and Siliquaria, and including also Magilus and Rhizochilus in the Purpurinæ, cannot possibly fertilize in any other way.

Very few prosobranchiates are viviparous. The eggs are usually enclosed, a number together, in tough leathery capsules, within which they undergo their larval stage of development. These capsules are variously aggregated, according to the genera. Littorina deposits its eggs in gelatinous masses, and the outer portion of the albumen of each egg hardens into a sort of shell; but ordinarily an egg-capsule is formed, and then the separate ova do not possess shells, but the capsule encloses a mass of albumen which is common to all the ova within it—sometimes several hundred. In this albumen the larvæ move about before leaving the capsule for the outer world.

The number of eggs deposited by the prosobranchiate mollusca is relatively small when compared with the lamellibranchiates, but enormous in comparison with the pulmonates. A nidimental string of *Pyrula canaliculata* contained fifty capsules, each enclosing about a hundred eggs, say five thousand eggs in all. In Buccinum the number is much greater.

The capsules are variously shaped and aggregated, and were formerly mistaken for and described and figured as zoophytes. It will assist us in our survey of their forms to present the classification of these bodies which was proposed by the cele-

brated Danish zoologist, A. Lund, based on their form and grouping, and in which almost all the variations are characterized.

FIRST CLASS.

Masses of capsules irregular. The egg-capsules by their union form irregular masses.

First Order. The egg-capsules are attached to each other. (*Capsulæ cohærentes.*)

1. The capsules open by a cleft.
2. The capsules open by a round hole closed by a round operculum or lid.

Second Order. The egg-capsules are attached to a common membrane, which is attached to some foreign body, and are separated from each other.

1. The capsules open by a cleft.
2. The capsules open by a round hole, which is closed by a lid.

a. The capsules are sessile upon the basal membranes. (*Sessiles.*)

a. *Tubiformes.*

b. The capsules are pedunculate, connected to the basal membrane by a stalk. (*Petiolatæ.*)

α. *Oviformes.*
β. *Cyathiformes.*
γ. *Infundibuliformes.*

SECOND CLASS.

Masses of capsules regular. The egg-capsules by their union form regular masses.

First Order. The egg-capsules are attached to each other. (*Capsulæ cohærentes.*)

Second Order. The egg-capsules are attached to a common basis (*Capsulæ adhærentes*).

a. The capsules are attached around an axis.

b. The capsules are attached longitudinally on one side of an axis.

α. *Sessiles.*
β. *Petiolatæ.*

How these capsular bodies (xvii) are developed is still a mystery.

Androgynous gastropods (Pulmonata, xviii, 8) present two distinct types of sexual organs: 1, *Monotremata*, in which the genital orifices, are confounded in a single cloaca, as in the helices; 2, *Ditremata*, in which the genital orifices are more or less distant, as in Limnæa.

In examining the monotremate type, we may take an Arion or Glandina, in which we find successively:—

1. An ovotestis or hermaphrodite gland. This is lobulated, and its follicles bear the ovules on the exterior and the spermatic cellules on the interior, the production of these elements not being always simultaneous. They come together at the opening of each lobule.

2. The excretory canal; which is tortuous and ends at the posterior extremity of the deferent canal and of the matrix, in the neighborhood of the albuminiparous gland.

3. This voluminous gland is yellowish white, and much distended at the period of reproduction. Its tissues are but slightly resistant and secrete a thick liquid in which swim some globules and granulations. It is supposed that the product of this gland envelops the eggs as they arrive at the matrix—into a posterior dilatation of which its excretory canal opens. At this point, or bordering on the excretory canal of the ovotestis and the excretory canal of the albuminiparous gland, commences the separation of the genital roads; afterwards the sperms and the ovules follow distinct routes.

4. The uterus or matrix, an intestiniform canal, which adheres throughout to the first portion of the deferent canal: in the dilations of its walls are found well-developed eggs.

5. When the uterus is separated from the deferent canal, it takes the name of vagina, and borders on a vestibule which opens without.

6. Into the vagina or vestibule is inserted the more or less long *receptaculum seminis* or copulatory pouch, containing the sperms after copulation.

7. The vestibule or cloaca is a more or less spacious sac into which open the vagina, the canal of the receptaculum and the verge, and which itself opens by the external genital orifice, placed usually behind the right tentacle.

8. Returning to the deferent canal, we find it divided into two distinct portions, an adhering posterior or prostatic and an anterior or free portion. The posterior part is joined to the concave margin of the uterus: its walls, which are not always complete, are exteriorly invested with a quantity of glandular follicles. The anterior part of the canal is very narrow and tortuous, and terminates in the sac of the verge.

9. The sack of the verge (penis) is oblong, cylindrical. A retractor muscle is placed near its posterior cul-de-sac. The verge opens as we have said in the vestibule.

Such are the fundamental portions of the most simple reproductive apparatus; but in a great number of other androgyna, they become complicated by the addition of accessory organs.

At the extremity of the excretory canal of the ovotestis, and

at the point where it unites with the albuminiparous gland, exists a small cæcum, sometimes simple, as in Bulimus, sometimes lobulated (*Helix palliata*, *H. thyroides*, *Succinea ovata*), and the walls of which are sometimes glandular; it is believed that the ovules are fecundated at the moment of passing into its cavity.

The accessory organs to the vagina consist of narrow, elongated, ramified diverticles, united in two groups and opening on each side by a common canal. They have been called multifid vesicles, mucous glands, vaginal prostates. The number of branches of each vesicle is 61 (*Helix vermiculata*), 30 to 40 (*H. pomatia*), 25 (*H. aperta*), 12 (*H. cespitum*), 8 (*H. aspera*), 4 (*H. conspurcata*), 2 (*H. serpentina*). In *H. pisana* and *H. arbustorum* there is only found a simple vesicle on each side; finally, in *Helix lenticula* and *H. acuta*, the vesicle is unique (Moquin-Tandon). In a number of species having no mucous vesicles we find a glandular lining of the vagina or *vaginal prostate* (Zonites, Daudebardia). Alongside the mucous vesicles opens into the vagina the sac of the curious *dart* (xviii, 9, 10), which consists of one or two ovoid purses having muscular walls, and within which are secreted a calcareous object, like a sharpened point or lance-head, with trenchant edges, rounded base, and channeled sides. This *telum veneris* is expelled at the moment of copulation and buries itself in the teguments of the snails in coitu.

The canal of the copulatory pouch usually has a diverticle called the copulatory branch; its size is narrow and uniform, and its length sometimes considerable (*Helix Niciensis*).

The vestibule is in relation with some appendages, the use of which is not known; such are the horn-like appendages of Parmacella. The genital cloaca is encircled by mucous glands in *Limax marginatus*: Moquin-Tandon designates them under the name of *vestibular prostates*.

The deferent canal may be encircled with prostatic glands, as well as its free portion.

The cul-de-sac of the penis-pouch is usually provided with a very long cylindrical appendage or *flagellum*, in which is formed the spermatophore. Nevertheless, a spermatophore equally exists in species having no flagellum; in which case, the secretion of this envelope of the seminal fluid takes place in the deferent canal (Dubreuil). The prostates or mucous glands open in the copulatory sac in Orthalicus and Liguus.

In order to understand the disposition of the genital organs in the androgyna having separate orifices, or *ditremata*, we will take for type those of Limnæa. The hermaphroditic gland and its excretory canal have the same disposition as in the *monotremata*. The albuminiparous gland is placed at the posterior

extremity of the uterus—which adheres very slightly to the first portion of the deferent canal, so that a slight traction suffices to separate them; consequently their walls are complete.

We find in the course of the uterus a yellowish pocket having glandular walls, in front of which the uterus swells, constituting the egg-reservoir. This dilatation contracts to form the vagina, in which opens the neck of the copulatory sac. The female orifice opens at the base of the neck near the pulmonary opening.

The deferent canal, in its adherent portion, is first flattened, then dilates and becomes pyriform. Its anterior portion is narrow cylindrical, and gains the base of the verge after having traversed a muscular mass in which it appears to lose itself. The male genital orifice is placed behind the right tentacle.

In Limnæa and Planorbis the inter-muscular course of the anterior portion of the deferent canal is very short, but in Vaginula it is very long. This canal is not always complete; in Oncidium, Oncidiella, Aplysia, etc., it is replaced by a simple gutter placed below the body, on the right side of the foot, or at the superior right side of the neck.

As in the monotremata, we find also in the ditremata accessory organs annexed to the reproductive system. The excretory canal of the ovotestis develops large and numerous glands (Ancylus); a seminal vesicle is inserted in the deferent canal (Vaginula); one or several diverticular appendages open in the vagina (Oncidiella, Melampus); very numerous mucous or multifid vesicles open in the sack of the verge (Vaginula); an extremely long flagellum is inserted in the posterior extremity of the penis-sack (Peronia), etc.

The Pteropoda are androgynous, their genital system resembling that of the Opisthobranchiates or of the ditremate pulmonates. In Hyalæa, there exists in effect: a rather large hermaphrodite gland, the excretory canal of which is provided with a long epididymic cæcum; a matrix to the posterior part of which adheres a sort of albuminiparous gland; a vagina where the copulatory pouch opens. The female is separated from the male orifice. The deferent canal is separate from the matrix and gains the verge, the orifice of which is near the mouth. In the ditremate pulmonata and the opisthobranchiates the copulatory act, of course, cannot be reciprocal between two individuals; one of them must take the part of female, the other of male; but a third can be male for the second, and so on, *ad infinitum*. Such is the mode of copulation in *Aplysia fasciata*. Fischer has seen chains formed by six individuals, the first functionally as female only, the following ones as male with the preceding and as female with the succeeding individual, the last fulfilling the rôle of male only. Geoffroy has seen similar chains formed by the Limnæans. In Helix copulation is reciprocal, each indi-

vidual playing the part of male and female at the same time; the genital vestibule is thrust out, the penis is unrolled like the finger of a glove and introduced into the vagina. The sperm is surrounded sometimes by an elongated filiform capsule, which is dilated for its anterior third with crenulated edges, or salient ridges, and which is called a spermatophore or capreolus. Such spermatophores are found in Arion, Parmacella, Peltella, Hyalina, Bulimulus, and in a large number of Helices, but in some of the latter genus they do not exist.

The presence of a spermatophore in the verge of each individual during copulation, evidently proves that fecundation must be reciprocal; nevertheless the pulmonates may copulate several times, as Van Beneden has found two spermatophores in the copulatory pouch of a Parmacella, and Fischer has seen four in that of *Bulimulus Delattrei*.

I have watched the copulatory act in American Helices, confined under a bell glass, and have been amused by the stupidity with which two individuals, each similarly minded, would continue to crawl around each other for many minutes, both so desirous to play the active part that neither was willing to remain immobile the moment necessary to secure the juxtaposition of their organs.

The spermatophore is formed in the deferent canal (Hyalina), or in the verge or its flagellum (Helix); after its dissociation in the copulatory pouch, the sperm is set at liberty; the spermatozoa enter the canal of this pouch and pass into the uterus; finally arriving in the epididymic cæcum, where they fecundate the ovules.

Terrestrial mollusks lay but few eggs; which are covered usually by a soft skin, but in the Testacella and tropical species of Bulimus and Achatina the egg is protected by a calcareous shell. The group Borus, including the largest species of Bulimus, inhabits the tropical regions of Brazil; the eggs of these shells are about an inch in length, or fully the size of a pigeon's egg (xvii, 100), with a shell of about the same thickness. The natives eat them. In a similarly isolated group of Achatina, inhabiting tropical Africa the eggs are equally as large as Borus. Generally the eggs are laid in a shallow hole dug in the ground and covered over, but some of the arboreal Philippine Island Bulimi construct a rude nest by curling up the leaf of a tree, in which they oviposit.

Fresh-water pulmonates, Limnæa, Physa, etc., lay from twenty to one hundred eggs, Ancylus, five or six; these are enveloped together in a gelatinous material.

The opisthobranchiates form a spirally rolled ribbon-like capsule for their eggs; such are those of Aplysia, Doris (xvii, 97), Bullæa, Eolis. A somewhat similarly shaped capsule,

consisting of two-thirds of a circle, narrowed into a neck at top, is produced by the American Naticas, *N. heros* and *N. duplicata* (xvii, 95). It is built up of eggs cemented together by sand and a gelatinous material; and is very common on our sea-beaches; the egg-pouches of Nassa are frequently attached to its inner wall.

Janthina attaches its eggs to the under side of a float (xvii, 99) composed of numerous cartilaginous air-vesicles, and secreted by its foot. *Lamellaria perspicua* digs a cavity in the colonies of certain compound Ascidians, upon which it usually feeds, and there oviposits.

Some Polynesian Helices (Endodonta) having a large umbilicus or basal axial opening in their shells, oviposit in it and cover the aperture with a thin diaphragm to prevent them from falling out. The eggs of Hipponyx, Capulus and Calyptræa are attached to the body of their mother, who thus appears to protect them, like the Janthina. On the other hand, the Limnæids not only take no care of their eggs, but are known to devour them.

Scaphopoda. The sexual organs, like some other portions of their anatomy, are more nearly related to the bivalve than to the encephalous mollusca. The sexes are separated, and the organs are composed of two symmetrical glands, the products of which are excluded through a posterior orifice, and through the open posterior end of the shell.

Acephala or *Pelecypoda* (xviii, 11, 17; xxii, 64). The sexual organs are composed of genital glands and vector channels. The genitals are symmetrical, paired and placed at the sides and base of the visceral mass; they are sometimes prolonged to the foot, sometimes to the lobes of the mantle. "*Pecten maximus*, *P. Jacobæus*, *P. glaber*, *Cardium*, *Pennanti*, *Pandora inæquivalvis*, *Anodonta cellensis* and *Ostrea edulis* have been recorded as hermaphrodite, and *Pecten varius*, *Cardium edule*, and most species of Unio as diœcious. But inasmuch as the male and female glands are not developed at the same time, it follows that an individual examined at different epochs may appear to be male or female or hermaphrodite. It is probable that some of the above determinations are therefore erroneous, and that more extended observation will greatly increase the number of diœcious bivalve mollusks. The difficulty in determining sex in these animals is increased by the fact that a single excretory canal serves for both ovules and spermatozoa. The male gland is whitish, the ovary usually reddish (Spondylus, Janira, Mytilus); these two glands are lobulated and generally distinct enough, but in the European Ostrea the spermatic and ovarian follicles are contiguous and, so to say, confounded."

"In some species (European Ostrea) the disposition of the

two elements of the genital gland is such that fecundation occurs partially before exclusion, but on account of the inequality in time of development of the sexual elements, the spermatozoa are usually transported by the surrounding water and serve to fecundate other individuals. In the diœcious bivalves the spermatic fluid is always conveyed by the water, as there is no act of copulation, and fecundation takes place probably in the pallial or branchial cavity of the females."

I have recorded the above observations of Dr. Fischer, which agree with the current belief upon the subject of sex in the lamellibranchiates, but the recent observations of Brooks * and Ryder upon the development of the American oyster, show that in that species at least, the sexes are always distinct. Mr. Ryder has established likewise the diœcious nature of *Mya arenaria.*

The number of eggs produced by the pelecypods is prodigious, amounting to a million or more, in the European Ostrea, and from ten to sixty millions in the American oyster; from 400,000 to 2,000,000 in Anodonta; perhaps as many as 12,000,000 in Teredo. Notwithstanding these enormous quantities a certain care of the eggs is exercised by Unio, Anodonta and Sphærium, which retain, hatch and protect their young for a period in their exterior branchiæ (*branchial uterus*). Dr. Lea has observed all the four leaves of the branchiæ filled with ova in several species of Unio, recalling the incubatory pouch of the marsupial mammalia.†

DEVELOPMENT.

The researches of John Hunter led him to the conclusion that each stage in the development of the highest animals corresponded to the permanent form of some one of the lower orders. Since his time a number of eminent investigators have partially confirmed this generalization, and more exactly defined it by a larger induction of facts. Woodward thus states it:

"In the earliest period of existence all animals display one uniform condition; but after the first appearance of special development, uniformity is only met with amongst the members of the same primary division, and with each succeeding step it is more and more restricted. From that first step, the members of each primary group assume forms and pass through phases which have no parallels, except in the division to which each belongs. The mammal exhibits no likeness, at any period, to the *adult* mollusk, the insect or the star-fish; but only to the ovarian stage of the invertebrata, and to more advanced stages

* Johns Hopkins Laboratory Studies, i, pt. 4.

† Raymond has observed that an Algerian fluviatile gastropod (*Melania tuberculata*), carries its young in the branchial cavity, and that these are accustomed to quit and re-enter this temporary lodging.

of the classes formed upon its own type. And so also with the highest organized mollusca; after their first stage they resemble the simpler orders of their own subkingdom, but not those of any other group."

The molluscan *ovum* (xix) consists of a colored yolk (*vitellus*), surrounded by albumen and either enclosed separately by a shell, or several together by a common envelope. On one side of the yolk is a pellucid spot, termed the *germinal vesicle*, having a spot or *nucleus* on its surface. This germinal vesicle is a nucleated cell, capable of producing other cells like itself; it is the essential part of the egg, from which the *embryo* is formed; but it undergoes no change without the influence of the *spermatozoa*. After impregnation, the germinal vesicle, which then subsides into the centre of the yolk, divides spontaneously into two; and these again divide and subdivide into smaller and still smaller globules, each with its pellucid centre or nucleus, until the whole presents a uniform granular appearance (*morula stage*). The next step is the formation of a ciliated *epithelium* on the surface of the embryonic mass; movements in the albumen become perceptible in the vicinity of the *cilia*, and they increase in strength, until the embryo begins to revolve in the surrounding fluid.*

Up to this point nearly the same appearances are presented by the eggs of all classes of animals—they manifest, so far, a complete "unity of organization." In the next stage, the development of an organ, fringed with stronger *cilia*, and serving both for locomotion and respiration, shows that the embryo is a *molluscous animal;* and the changes which follow soon point out the particular *class* to which it belongs. The rudimentary *head* is early distinguishable by the black eye-specks; and the *heart* by its pulsations. The digestive and other organs are first

* According to the observations of Professor Lovén (on certain bivalve mollusca), the ova are excluded immediately after the inhalation of the spermatozoa, and apparently from their influence; but impregnation does not take place within the ovary itself. The spermatozoa of *Cardium pygmæum* were distinctly seen to penetrate in succession the outer envelopes of the ova, and arrive at the vitellus, when they disappeared. With respect to the "germinal vesicle;" according to Barry, it first approaches the inner surface of the vitelline membrane, in order to receive the influence of the spermatozoa; it then retires to the centre of the yolk, and undergoes a series of spontaneous subdivisions. In M. Lovén's account it is said to "burst" and partially dissolve, whilst the egg remains in the ovary, and before impregnation; it then passes to the centre of the yolk, and undergoes the changes described by Barry, along with the yolk, whilst the *nucleus* of the germinal vesicle, or some body exactly resembling it, is seen occupying a small prominence on the surface of the vitelline membrane, until the metamorphosis of the yolk is completed, when it disappears. It has been named polar globule, and is supposed to be expelled by the micropyle.

"sketched out," then become more distinct, and are seen to be covered with a transparent shell. By this time the embryo is able to move by its own muscular contractions, and to swallow food; it is therefore "hatched," or escapes from the egg.

Cephalopoda (xix, xx, 39–42). "In the dibranchiates the yolk undergoes partial division, and the blastoderm (yolk-sac) formed upon the face of it by the smaller blastomeres, spreads gradually over the whole ovum, enclosing the larger and more slowly dividing blastomeres. The mantle makes its appearance as an elevated patch in the centre of the blastoderm, whilst the future arms appear as symmetrically disposed elevations of the periphery, on each side of the mantle. Between these and the edge of the mantle, two longitudinal ridges mark the rudiments of the epipodia, while the mouth appears in the middle line in front of the mantle, and the anus, with the rudiments of the gills, behind it. The rest of the blastoderm forms the walls of a vitelline sack, enclosing the larger blastomeres.

"The pallial surface now gradually becomes more and more convex, the posterior margin of the mantle growing into a free fold, which encloses the pallial chamber and covers over the gills.

"The internal shell is developed in a sac formed by an involution of the ectoderm of the mantle. The epipodia unite behind, and give rise to the funnel, while the antero-lateral portions of the foot grow over the mouth, and thus gradually force the latter to take up a position in the centre of the neural face, instead of in front of it. The yolk-sack gradually diminishes, and the contained blastomeres are finally taken into the interior of the visceral sac, into which the alimentary canal is gradually drawn." —Huxley, "Anatomy of Invertebrated Animals."

At a later period of development, respiratory movements are performed by the alternate dilatation and contraction of the mantle, and the position of the ink-bag is revealed by its color through the transparent flesh. The shell of the young Sepia, observes Kölliker, by the time it is prepared to leave the nidimental capsule has already formed, but except the nucleus, which is calcified, its fine layers are horny and transparent. The fins are proportionally broader than those of the mature animal.*

The development of Nautilus, equally with its nidus is unknown.

Gastropoda (xx, 43–53). The transformation of the egg into the embryo is preceded by division of the yolk mass into blasto-

* For a fuller account of cephalopodous development, see an excellent paper on that of Loligo Pealei, by W. K. Brooks, *Anniversary* Memoirs, Boston Soc. Nat. Hist., 1880.

meres (cells), which begins immediately after fertilization and is speedily completed (Morula stage). The yolk assumes the appearance of a cluster of round nucleated cells, the large ones internal, the smaller external; forming the embryo—except a portion which remains as nutritive material. The yolk first loses its spherical form, elongates somewhat, develops upon its entire surface a delicate ciliary covering, and begins its wonderful rotary movement.* At the anterior part of the body a circlet or crown of long cilia arises; the portion of the body supporting this is then elevated into a ridge, then a ring, and finally it develops on each side into a rounded lobe. Both lobes together present somewhat the appearance of the figure 8: these are the vela which Forskäl first described as the organs of locomotion of the univalve molluscan larvæ. Most of the prosobranchiate and episthobranchiate larvæ are velamentous. Immediately below the velum the mouth is developed as an invagination; at the posterior end the anus is similar formed: both open into the intestinal cavity which has been formed by the displacement of the large yolk-cells in the centre. An intestine is now present, and the large cells which are somewhat heaped up posteriorly, become in large part the liver and intestinal wall. A body-cavity between this large-celled intestinal wall and the small-celled body-wall is not yet present, and originates later by a separation of the two walls and the appearance of a fluid between them.

Below the mouth the foot arises as a blunt ciliated appendage, whilst the ciliated covering of the rest of the body has become lost. The velum, that at first surrounded the fore-part of the [illegible] elevated to the dorsal side after the appearance of the [illegible], so that the mouth is not placed in the middle of the velum, but beneath its narrow portion, and is dorsally overhung by the velum, whilst ventrally the foot extends beyond it. The [illegible] at its posterior dorsal [illegible] shell appears, in which also [illegible] may be detected: at the posterior [illegible] at the same time. The [illegible] in the velum the [illegible] the side of the [illegible] then appear [illegible] same time, along- [illegible] at first, like the [illegible] internally, the [illegible] nervous system. [illegible] Along

* [illegible] see the [illegible] stage in [illegible]

the border of the shell the body-wall is raised into a ridge, the beginning of the mantle, and, as the shell grows farther forward, the intestine in most prosobranchiates (not in Chiton), instead of terminating posteriorly, begins to be pushed forwards, so that the anus is likewise advanced with the border of the shell to the right side of the body.

The pharynx now appears as a distinct portion of the animal and within it, the different parts of the lingual membrane may be distinguished as the middle, inter, and lateral plates, and according to Troschel's observation, the genus to which the larva belongs may be already determined by the teeth. One may already notice the commencement of the spiral winding of the shell, and within it is contained one loop of the intestine and many large cells or yolk-spheres, which become the liver. A larval shell exists even in those mollusks (Nudibranchiates) which have no shell in the adult state; it is closed by means of an operculum.

As soon as the anus commences to be pushed forwards and the intestine becomes a distinct canal, the body-cavity begins to appear with blood in it. There is as yet nothing to be seen of the heart, and the circulation of the blood is effected by the contraction and dilatation of the hollow foot, or often by means of an elevation on the neck, consisting of a meshwork of fibres, the cervical vesicle. By means of the heart, as soon as it is developed, the fluid in the body-cavity, the blood, is put into motion, but often, as in Paludina, this circulation is assisted, and probably more effectively, by the contraction and dilatation of the foot.

At this stage the larvæ mostly leave the albumen of the egg-corpuscles, in which, up to this time, they have been enclosed, and swim freely about by means of their velum. Finally, the mantle-cavity is formed; the mantle, heretofore simply a ridge around the front of the shell, now extends itself from the body as a fold and covers, with the shell, the mantle or respiratory cavity, in the base of which, a contractile structure—the heart—may soon be observed. The foot is developed still further, the velum, the only exclusively larval organ, slowly disappears, the tentacles are prolonged and in this way the swimming larva slowly becomes the creeping animal—of which the various organs finally attain maturity.

Prof. W. B. Carpenter has observed* that whilst a capsule of *Purpura lapillus* contains from 500 to 600 vitelline bodies, nevertheless only from 12 to 30 embryos are produced, each of these having from 20 to 30 times the bulk of the ovum from which it sprang; so that the material contained in the original mass of

* *Rept. Brit. Assoc.*, 108, 1854.

eggs is evidently appropriated by the comparatively few embryos which are thus developed at its expense. Prof. Carpenter examined a large quantity of capsules, in which a considerable number of small, free embryos presented themselves before the conglomeration of the great mass of the ova, so that he could not doubt they were generated independently of it. The embryos soon attach themselves to the conglomerate yolk-mass, and by the action of their cilia, the small segments of which it is composed are driven down into their interior, which is soon distended by them. The bodies which coalesce after segmentation, Prof. Carpenter regards as imperfectly fertilized ova, and they evidently supplement the insufficient supply of nutriment contained in the yolk-sack of each developing embryo. A similar consumption of a portion of the ova takes place in Buccinum and Nassa and very probably in a large portion of the prosobranchiates.

Generally, the shell and operculum developed within the egg-capsule are retained by the animal, forming simply the nucleus of the adult structure, but in a few cases a temporary shell and operculum are provided, which are eventually lost. Animals in this larval condition were formerly described as distinct genera of pelagic gastropods, until Krohn, and after him Macdonald,* showed their true relationship; in this the lingual dentition became an important agent to indicate the connection with adult forms. Krohn discovered at Messina a curious mollusk which he called Echinospira (xx, 49–50), and which proved to be the larval state of *Marsenia conspicua*. He found the nucleus of the permanent shell to be developed within the spiny nautiloid larval shell, and that the latter was eventually cast off. I figure some other pelagic larval mollusks: Macgillivraya, with its curious six- or eight-lobed tentaculiform velum (xx, 44–46), which is the larva of Dolium, and Cheletropis = Sinusigera (xx, 47–48) which, on account of its dentition has been (probably erroneously) referred to the Muricidæ; † but in all the egg-capsules of Murex which I have examined the contained shells are miniatures of the adults. Mr. Arthur Adams has referred a Cheletropis to *Purpura biserialis*, and it is just possible that the species belongs to the Purpurinæ. Investigations of the transformations of free swimming larvæ are made with difficulty, and it will probably be many years before we shall have acquired a sufficient body of facts to understand the conditions

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* Macdonald, On Metamorphosis of Mollusca, *Linn. Trans.* xxii. 241; xxiii, 69.

† Chiropteron semilunare, Sars (*Beskriv. og Jagtta gelser*, t. 14. f. 88, 1835), is probably the larva of Aporrhais. *Mörch*, *Ann. Mag. N. Hist.*, 3d ser., xvi, 78, 1865.

under which a large portion of the prosobranchiates undergo this larval transformation after exclusion, whilst in other genera the newborn mollusk is the epitome of the adult.

In the larval Chiton the velum is replaced by a crown of cilia, and eyes are present although the adult is blind. The shell, when it appears, is the miniature of the mature form.

In the pulmonata the velum is rudimentary, represented by a ciliated tuft on each side of the mouth. In Limax there exists on the dorsal posterior extremity of the body a pedunculated vesicle, the contractions of which, alternating with those of the vitelline sac, produce a sort of circulation which diminishes and disappears as the heart is formed. The embryonic pulmonata possess primitive kidneys or *Wolfian Bodies*, consisting of paired tubes, curved, without communication one with the other, and the walls of which are provided with secretory cells. These organs are formed by a small invagination of the ectoderm. The embryonic shell of the pulmonates constitutes the apex of the adult shell; where it is usually distinguishable by smoothness of surface, hyaline and colorless appearance.

Pteropoda (xx, 53). Most of these in the larval state resemble those of the marine gastropods. They have a ciliated velum and an operculated shell. The velum atrophies on the development of the wings. The gymnosomate pteropods (Pneumodermon, Clio), pass through a stage during which they are provided with three girdles of cilia, and resemble the annelid embryos—as do those also of the Dentalium.

Scaphopoda (xx, 54, 55). The larval Dentalium is provided with several circles of cilia. Its shell is constituted at first of two symmetrical portions, with margins in contact; these finally unite to form the single tube of the tooth-shell, an elongated cylinder open at each end.

Pelecypoda (xxi). The young bivalves are hatched before they leave their parent; the oviducts open into the dorsal channels, and the eggs are received into the gill-tubes and there retained until the escape of the young mollusk. In Unio and Anodonta (xviii, 11), the outer gills only receive the eggs, with which they are completely distended in the winter months. In Sphærium the inner gills form the *marsupium*, containing from ten to twenty fry: some of these remain until nearly a fourth the length of their parent.

The forms which young bivalves pass through, present distinct differences in several families, so that even in the present state of embryological knowledge, some five or six types of development are known. Even in the same family there may be a great dissimilarity, as in the case of the marine and fresh-water forms of the Mytilidæ. The following account refers to the type to which the young of Crenella belong. At first they have a swim-

ming disk, fringed with long *cilia*, and armed with a slender tentacular filament (*flagellum*). At a later period this disk disappears progressively as the labial palpi are developed; and they acquire a foot, and with it the power of spinning a byssus. They now have a pair of eyes situated near the labial tentacles which are lost at a further stage, or replaced by numerous rudimentary organs placed more favorably for vision, on the border of the mantle.

The shells of the embryonic Uniones and Anodons (xx, 56, 57), are so dissimilar to those of the adults, that they were at one time considered to be parasites (Glochidium). The valves of the shell are usually triangular, with a flattened hinge-line and they frequently have incurved hooks on the basal margin, by the help of which the larvæ, after they leave the parent, attach themselves to its shell, or to fishes and other floating bodies. In this position they undergo metamorphosis, and eventually fall off and sink to the bottom as minute fresh-water Mussels. The young of some species are attached by a filament, and Dr. Lea believes that they are always *unimusculose* (monomyary), the muscle dividing during metamorphosis.*

The development of the oyster (xx, 60–63), presents some interesting particulars. The embryo, at first spherical, becomes cordiform, then two or three vibratile cilia appear on its surface, and a transparent tract indicates the place of the hinge—in the vicinity of which is formed a calcareous deposit, the first indication of the valves. The velum soon greatly develops, so that its complete retraction is not possible. By the aid of this organ the animal swims rapidly, but without knocking the surrounding embryos. The mouth is encircled by a crown of cilia. The velum finally disappears, or is possibly transformed into the labial palpi. Finally the shell, until now equivalve and free becomes fixed for life, and from this moment commences the normal life of this mollusk.†

In Pisidium, the oral extremity of the embryo is velated. On its dorsal face the tegument is raised to form a mantle, at the centre of which is produced by invagination a small sac or *preconchylian gland*, having a temporary existence (Lankester). This gland occupies the place of the ligament; the shell is afterwards developed on the surface of the mantle under the form of a

* Lea, Obs. on Unio, vi, 43.

† The eggs of the American oyster (*O. Virginica*), are fertilized outside the body of the parent, and the young swim at large during the period in which the fry of the European species (*O. edulis*) are sheltered in the mantle of the parent. Segmentation of the vitellus in the first named is, according to Brooks, completed in about two hours.—*Am. Jour. Science*, xviii, 425, 1879.

chitinous cuticle. There exists, nearly always, a byssal gland at the base of the foot.

REPRODUCTION OF DESTROYED ORGANS.

It appears from the experiments of Spallanzani, that snails, whose ocular tentacles have been destroyed, reproduce them completely in a few weeks; others have repeated the trial with a like result. But there is some doubt whether the renewal takes place if the brain of the animal be removed as well as its horns. Madame Power has made similar observations upon various marine snails, and has found that portions of the foot, mantle, and tentacles, were renewed. Mr. Hancock states that the species of Eolis are apt to make a meal off each other's *papillæ*, and that, if confined in stale water, they become sickly and lose those organs; in both cases they are quickly renewed under favorable circumstances.

The Cephalopoda frequently lose a portion of an arm or the entire limb in the course of their active existence, but soon develop another from the stump of the destroyed member, and only differing from it in being less colored.

In some cases mollusks can spontaneously detach portions of their body. I have already shown in the chapter on sexual organs how the hectocotylized arm of the Octopus becomes detached from its owner and remains within the pouch of the female, and that a similar specialized arm developes in due time to take the place of the lost member; only to detach itself in turn. Quoy and Gaimard several times saw the *Harpa ventricosa* amputate the posterior portion of the foot by muscular contractions, the lost part being subsequently replaced by growth. In two Cuban Helices also (*H. crassilabris* and *H. imperator*), Dr. Gundlach has seen a similar amputation and somewhat rapid regeneration.

The bivalve genera Solen and Solecurtus readily lose a portion of their siphons. Fischer has often found the detached extremities of siphons alongside the beds of *Solen marginatus* in the Basins of Arcachon.

I have already considered the renewal of fractured portions of the shell (pp. 20, 32) and operculum (p. 49), as well as the abnormal duplication of both (p. 52).

HABITS AND ECONOMY OF THE MOLLUSCA.

"Every living creature has a history of its own; each has characteristics by which it may be known from its relatives; each has its own territory, its appropriate food, and its duties to perform in the economy of nature. Our present purpose, however, is to point out those circumstances, and trace the progress of those changes which are not peculiar to individuals or to species, but have a wider application, and form the history of a great class.

"In their infancy the molluscous animals are more alike, both in appearance and habits, than in after-life; and the fry of some of the aquatic races are almost as different from their parents as the caterpillar from the butterfly. The analogy, however, is reversed in one respect; for whereas the adult shell-fish are often sedentary or ambulatory, the young are all swimmers; so that by means of their fins and the ocean-currents, they travel to long distances, and thus diffuse their race as far as a suitable climate and other conditions are found. Myriads of these little voyagers drift from the shores into the open sea and there perish; their tiny and fragile shells becoming part of a deposit constantly accumulating, even in the deepest parts of the sea.

"Some of these little creatures shelter themselves beneath the shell of their parent for a time, and many can spin silken threads with which to moor themselves, and avoid being drifted away. They all have a protecting shell, and even the young bivalves have eyes at this period of their lives, to aid them in choosing an appropriate locality.

"After a few days, or even less, of this sportive existence, the sedentary tribes settle in the place they intend to occupy during the remainder of their lives. The tunicary cements itself to rock or sea-weed; the ship-worm adheres to timber, and the Pholas and Lithodomus to limestone rocks, in which they soon excavate a chamber which renders their first means of anchorage unnecessary. The Mya and razor-fish burrow in sand or mud; the mussel and Pinna spin a byssus; the oyster and Spondylus attach themselves by spines or leafy expansions of their shell; the Brachiopoda are all fixed by similar means, and even some of the gastropods become voluntary prisoners, as the Hipponyx and Vermetus, the Rhizochilus and Magilus.

"Other tribes retain the power of traveling at will, and shift their quarters periodically, or in search of food; the river-mussel drags itself slowly along by protruding and contracting its flexible foot; the cockle and Trigonia have the foot bent, enabling them to make short leaps; the scallop (*Pecten opercularis*) bounds rapidly by opening and shutting quickly its tinted

valves, and the larger species are thus able to make leaps of one or two yards; the nearly related Lima vaults through the water like the butterfly through the air.—(MOQUIN-TANDON.) Nearly all the gastropods creep like the snail, though some are much more active than others; the pond-snails can glide along the surface of the water, shell downwards; the nucleobranchs and pteropods swim in the open sea. The cuttle-fish have a strange mode of walking, head downwards, on their outspread arms; they can also swim with their fins, or with their webbed arms, or by expelling the water forcibly from their branchial chamber; the calamary can even strike the surface of the sea with its tail, and dart into the air like the flying-fish.—(OWEN.)

"By these means the mollusca have spread themselves over every part of the habitable globe; every region has its tribe; every situation its appropriate species; the land snails frequent moist places, woods, sunny banks and rocks, climb trees, or burrow in the ground. The air-breathing limneids live in fresh water, only coming occasionally to the surface; and the auriculas live on the sea-shore, or in salt-marshes. In the sea each zone of depth has its molluscous fauna. The limpet and periwinkle live between the tide-marks, where they are left dry twice a day; the Trochus and Purpura are found at low water, amongst the sea-weed; the mussel affects muddy shores, the cockle rejoices in extensive sandy flats. Most of the finely-colored shells of the tropics are found in shallow water, or amongst the breakers. Oyster-banks are usually in four or five fathoms water; scallop-banks at twenty fathoms. The Terebratulæ are found at still greater depths, commonly at fifty fathoms, and sometimes at one hundred fathoms or more, even in Polar seas. The fairy-like Pteropoda, the oceanic snail, and multitudes of other floating mollusks, pass their lives on the open sea, forever out of sight of land; whilst the Litiopa and Scyllæa follow the gulf-weed in its voyages, and feed upon the green delusive banks."—(WOODWARD.)

Parasitism is rare among mollusks, and only exists in connection with the Echinodermata and Cœlenterata. The best known parasitic genus is Stylifer, a little gastropod, numerous in species. *S. Turtoni* attaches itself to the spines surrounding the anus of different British species of Echinus (sea-urchins); *S. astericola* of the Galapagos Islands digs itself a comfortable dwelling in the tissues of an Asterias (Cuming); *S. Orbignyi* lodges itself in the spines of Cidaris, causing a malformation. Some of the nearly-related genus Styliferina live on Ophiura, and certain species of Eulima in Holothuria. *Entoconcha mirabilis* is found floating freely in the body of Synapta, in which it develops its little operculated shells. J. Müller, who discovered this curious parasite, supposed that there existed in Synapta an

alternating generation, one of the forms being the echinoderm, the other the mollusk; but this theory is not tenable, and it is certain that Entoconcha is a gastropod, but whether related to Eulima, or whether the larva of a nudibranchiate, has not been determined. Some species of Odostomia are scarcely obtained elsewhere except fixed to the ears of the valves of Pecten. They may live on the secretions of that mollusk, or possibly upon minute animals found upon the valves.

Magilus, Leptoconcha, Cryptobia, Coralliophila, Rhizochilus, Pedicularia, etc., live among polyps and on Alcyonaria; and many Eolidians remain attached to Hydrozoa and Bryozoa. *Lamellaria perspicua* feeds on Leptoclinum, one of the compound ascidians, and deposits its eggs in a cavity which it digs in the colonies of these animals.

Among bivalves, the European species *Montacuta substriata* is found attached to the spines of sea-urchins; the *Lepton parasiticum*, of Kerguelen's Island has been found in the vicinity of the mouth of a Hemiaster (Dall); *Modiolaria marmorata* is nearly always encysted in the teguments of simple ascidians; Vulsella, and Crenatula and a number of species of other genera live in sponges; Tridacna and Pedum on coral.

In fresh waters, young Unios and Anodons fix themselves on the opercula, the lips and fins of fishes (Leuciscus, Gobio). Their larval byssus and the spiny border of their larval shells favor this parasitism. The true nature of these young mussels was at first mistaken, and they were described under the name of *Glochidium parasiticum*.

Food. The food of the mollusca is either vegetable, or animal. Nearly all the land snails are vegetable-feeders, and their depredations are but too well known to the gardener and farmer in Europe where many a crop of winter corn and spring tares has been wasted by the ravages of the "small gray slug." In the drier climate of the United States where the snails are mostly compelled to seek the shade and dampness of forests, they are seldom destructive to crops. They have their likings, too, for particular plants, most of the pea-tribe and cabbage-tribe are favorites, but they hold white mustard in abhorrence, and fast or shift their quarters while that crop is on the ground. Some, like the "cellar-snail," feed on cryptogamic vegetation, or on decaying leaves; and the slugs are attracted by fungi, or any odorous substances. The round-mouthed sea-snails (holostomata) are nearly all vegetarians, and consequently limited to the shore and the shallow waters in which sea-weeds grow. Beyond fifteen fathoms, almost the only vegetable production is the nullipore; but here corals and horny zoophytes take the place of algæ, and afford a nutritious diet.

The whole of the bivalves live usually on infusoria, or on

microscopic plants, brought to them by the current which their ciliary apparatus perpetually excites; such, too, must be the sustenance of the Magilus, sunk in its coral bed, and of the Calyptræa, fettered to its birth-place by its calcareous foot. Fresh-water bivalves, Sphærium, Unio, are known to have a liking for decaying animal food; the former being frequently found attached to it, the latter often burrowing in the putrescent mass.

The carnivorous tribes prey chiefly on other shell-fish, or on zoophytes; since, with the exception of the cuttle-fishes, their organization scarcely adapts them for pursuing and destroying other classes of animals. One remarkable exception is the Testacella, which preys on the common earth-worm, pursuing it in its burrow.

Most of the siphonated univalves are animal-feeders; the carrion-eating stromb and whelk consume the fishes and other creatures, whose remains are always plentiful on rough and rocky coasts. Many wage war on their own relatives, and take them by assault; the bivalves may close, and the operculated nerite retire into his home, but the enemy, with rasp-like tongue, armed with siliceous teeth, files a hole through the shell—vain shield where instinct guides the attack! Of the myriads of small shells which the sea heaps up in every sheltered "ness," a large proportion will be found thus bored by the whelks and purples; and in fossil shell-beds, such as that in the Touraine, nearly half the bivalves and sea snails are perforated—the relics of antediluvian banquets. The perforation is always made at a point covering the essential organs of the victim. In the acephala it is found at the central part of one valve, usually near the beaks, in the encephala about the middle of the length of the shell. Boring mollusks are a veritable plague to the owners of oyster-banks: the *Murex erinaceus* in Europe, the *Urosalpinx cinerea* on the Atlantic and the *Purpura crispata* on the Pacific coasts of the United States are enemies upon whom the oyster-fisher wages constant warfare. The carnivorous gastropods often pay the penalty which they inflict, and not unfrequently the shell of the *Natica duplicata* may be found, bored through at a spot where its late inhabitant was powerless to repel the intruder.

There are certain carnivorous genera among the terrestrial gastropods: these are (besides the Testacella), Daudebardia, Glandina, Ennea, Rhytida, etc. They live on small species of the herbivorous genera, Helix and Bulimus which they detach from their shells by means of their tongues. Sometimes they swallow both shell and proprietor; as Fischer found an Opeas intact in the stomach of a Glandina. A number of usually herbivorous species of terrestrial mollusks have developed carnivorous instincts when imprisoned with other species.

The Aplysia or sea-hare will, in captivity, eat its eggs, soon after laying them; and Limnæa has been known to eat its progeny when urged by hunger: indeed, many of the terrestrial and fluviatile mollusks, herbivorous by habit, will eat animal food occasionally — especially when, in captivity, they are deprived of their usual food supplies. Far away from land the Carinaria and Firola pursue the floating acalephe, the Janthina varies its diet by occasionally swallowing smaller individuals of its own species (Coates); and the argonaut, with his relative, the Spirula, both carnivorous, are found on the "high seas," in almost every quarter of the globe. The most active and rapacious of all are the calamaries and cuttles, who vindicate their high position in the naturalist's "system," by preying even on fishes, as well as lamellibranchs and crustaceans.

As the shell-fish are great eaters, so in their turn they afford food to many other animals; fulfilling the universal law of eating and being eaten. They furnish precious resources of alimentation to man. The cephalopods (Octopus, Sepia, Loligo) are captured for the market in the Mediterranean countries, especially in Italy), as well as in Japan and China; and dried cuttle-fish are regularly exported from China to San Francisco, California, where the Chinese inhabitants use them for soup.

Among the marine gastropods Patella, Haliotis, *Buccinum undatum*, Littorina, etc., are sent in quantities to the markets of London and Paris; Murex and Turbo are eaten in Italy; *Strombus gigas* and *Trochus pica* in the West Indies (Beau); *Strombus Luhuanus*, *Turbo chrysostomus*, *Trochus Niloticus*, *Patella testudinaria*, etc., at New Caledonia (Montrouzier); *Dolabella Teremidi*, at Tahiti (Rang); *Strombus tricornis*, *Murex Erythræus*, *Melongena paradisiaca*, at Suez (Vaillant); *Fusus colosseus*, *Rapana bezoar*, *Purpura luteostoma*, on the coast of China (Debeaux); *Turbo niger*, *Concholepas Peruvianus*, in Chili (d'Orbigny). A few fluviatile gastropods are eaten: Navicella and Neritina by the negroes of the Isle of France (Récluz); *Ampullaria effusa*, *Neritina punctulata*, by those of Guadeloupe, W. Indies (Beau); Paludina by the natives of Cambodia.

Among the terrestrial gastropods the Helices were most highly esteemed as a dainty dish by the ancient Romans, and they are still regularly sold in large quantities, living or cooked in the markets of France, Spain and Italy. I have seen cooked snails offered in the streets of London at one penny per plate. *Helix pomatia*, one of the largest of European snails, is considered still, as it was by the Romans, the best of the edible species, but a number of others are regularly brought to market. Colonies of snail-eating peoples have naturalized their delectable food in distant quarters of the earth; thus *Helix nemoralis* is estab-

fished at Charleston, S. C.; *H. lactea* at Montevideo; *H aspersa* in California, etc. The natives of New Caledonia eat quantities of the large bulimi (Placostylus) characteristic of that archipelago; in Guatemala the large *Helix Ghiesbreghti* is eaten.

The pelecypoda or bivalve shell-fish are consumed in such quantity as to rank with the principal kinds of animal food. The oyster trade has become enormous and is constantly growing. The best known edible species are *Ostrea edulis*, in Europe; *O. angulata*, on the west coasts of France and Portugal; *O. lamellosa*, in the Mediterranean; *O. borealis*, and *O. Virginica*, on the Atlantic coast of the United States; *O. parasitica*, in the West Indies; *O. tuberculata*, at the Cape of Good Hope; *O. cornucopiæ* at Suez, etc.

The sea-mussel (*Mytilus edulis*) is largely gathered by the inhabitants of the European coasts, and I have seen it for sale in many coast towns. It is sufficiently valuable to be cultivated carefully in parks on the west coast of France and the northern shores of Germany. The same species is abundant on the Atlantic coast of the United States, but does not appear to be much esteemed, and is rarely offered for sale.

But nearly all the marine bivalves are edible; among those most used, may be cited the species of Pecten, Spondylus, Arca, Cardita, Cardium, Venus, Donax, Cytherea, Solen, Mya, Pholas of European seas; *Venus Mercenaria*, *Mya arenaria*, *Mactra solidissima*—all called clams, *Solen ensis*, the razor-shell, and *Pecten irradians*, of the United States; Lucina and Donax, in the West Indies; *Avicula margaritifera*, *Cytherea Arabica*, at Suez (Vaillant); *Cytherea petechialis*, *Lucina Philippiana*, *Mactra veneriformis*, in China (Debeaux); *Mesodesma striata*, *Lucina tigrina* in New Caledonia (Montrouzier); *Tridacna mutica*, in the Caroline Islands, and *T gigas*, at New Ireland (Quoy and Gaimard); *Mesodesma Chilensis* at Valparaiso (d'Orbigny).

Fresh-water bivalves are less sought for food on account of the insipidness of their flesh. The many species of Unio of the Western and Southern rivers of the United States are scarcely at all eaten; but in France the indigenous Unionidæ are collected in some of the poorer districts. *Anodonta edulis* is cultivated for food in the ditches of Song-Kiang-Fou, China, (Heude); *A. sempervirens* is eaten by the natives of Cambodia (Jullien); and the Ætheria, or fresh-water oyster, which forms its "banks" in the rivers of Africa, is consumed by the negroes.

The Kjokkenmöddings, or kitchen refuse-heaps, which have been found so abundantly on both shores of the United States, Brazil, Denmark, Scotland, New Zealand, Australia, etc., are mounds, sometimes hundreds of yards in length, and usually composed almost entirely of the shells of edible mollusks, mixed

with the bones of mammals, birds, fishes, the ashes of fire, broken pottery, and domestic implements made of stone or bone. They are the remains of pre-historic feasts; and some of these mounds are so great as to indicate that they were resorted to for centuries. The species of shells are usually those which now inhabit the neighboring sea, and which are still eaten.

Mollusks are gathered in great quantity for fishing-bait; thus the cuttle-fish is used in the cod-fishery, off Newfoundland; the Patella (limpet) and Buccinum (whelk) on the British, and the Octopus and Cardium on the French coasts. A large number of wild animals either habitually live on mollusks, or take them in default of other food; the rat and the raccoon seek for them when pressed by hunger; the musk-rat loves Uniones and the open valves, remains of his feasts, are often seen near American streams;* the South American otter and the crab-eating opossum constantly resort to salt marshes, and the sea, in order to prey on the mollusca. The walrus lives almost exclusively on *Mya arenaria* and *M. truncata*; some cetaceans destroy prodigious quantities of mollusks and are *par excellence* the squid-eaters or Teuthophages (Eschricht); thus in the stomach of divers Hyperoödons have been found more than two quarts of cephalopod beaks (Jacob), several hundred sepia beaks (Bylerly), finally, more than eighteen quarts of these beaks, and nothing else (Gray). Twenty-nine beaks were found in the first stomach of a grampus, and that of a globicephalus contained nothing else (Fischer). In the regions frequented by these cetaceans may be seen thousands of the bodies of Sepia, thrown to one side after the head has been bitten off and eaten (Lesson); these bodies are probably rejected on account of the cuttle-bone, which the whale does not appear to consider nutritious. Ambergris, an intestinal product of the cachelot, contains the beaks of cephalopods, which probably communicate to this substance its musky odor.

The Balæna is said by several authors to live habitually on the Pteropoda (Limacina and Clio), but it has been proven that banks of small crustaceans (Cetochilus) form its principal food.

Sea-fowl search for littoral species at every ebbing tide, whilst the ducks and herons destroy fresh-water mollusks, and many birds eat terrestrial snails. The Kagou (*Rhynochetus jubatus*) of New Caledonia lives on the large Bulimi, the shell of which it pierces with its beak (Marie). The Gorfous (*Eudyptes chrysolopha*), which swims very well upon the ocean, even attacks the cephalopods, and the stomach of one of these birds was found to contain about twenty mandibles of Ommastrephes (Vélain).

* This animal is believed to bring the mollusk out of the water and place it where the heat of the sun kills it, causing the valves to open.

Reptiles furnish a few destroyers of mollusks. Thus the tortoises of our gardens eat snails, and it is common to put these animals in a cellar infested with slugs in order to exterminate them; the toad eats both snails and Helices; the frog and water-lizard eat the fresh-water snails; the Pseudopus, of our menageries, eats snails only.

In their own element, marine mollusks are perpetually devoured by fishes. The haddock is a "great conchologist;" and some rare northern shells (Glycimeris, Buccinum, Neptunea), have been rescued unbroken from the stomach of a cod. (One of them furnished thirty-five to forty shells of *Buccinum undatum.*) Hyndman has estimated at 35,000 the mass of a small bivalve shell (*Turtonia minuta*) found in the stomach of a mullet (Jeffreys). Some fishes break the most solid shells; thus the valves of a Cyprina cannot resist the teeth of the cat-fish (*Anarhichas lupus*). The Octopus, notwithstanding its intelligence, cunning and powers of defense, is very frequently the victim of the Conger Eel, which seizes it in its most secluded retreats.

The oyster-culturists at Arcachon (France) dread the ray, a fish which attacks young oysters. In one night, fourteen of these fishes destroyed more than 170,000 young oysters in a single parc. In the Oostanaula River, Georgia, the drum-fish (*Pogonias chromis*, L.) crushes the valves of Unios with its palatal armature in order to eat the soft parts.*

Articulated animals destroy but few shell-fish. Fischer has seen crabs break the shell of young oysters with their pincers; *Libinia canaliculata*, the common spider-crab of the American coast is very destructive to oyster-beds, and some others of our crabs have probably similar habits. Carabus, Georus, Staphilinus, Cychrus and Sylpha, among insects attack terrestrial gastropods. The larva of *Drillus Mauritianus* detaches with its mandibles the operculum of *Cyclostoma mamillare*, and undergoes metamorphosis within its shell, after having eaten the rightful proprietor (Lucas). Larval glow-worms also live on Helices, and will eat two or three before passing into the nympha state (Godard). *Cochleoctonus vorax* lays an egg in the body of different species of snails; when hatched, the larva feeds upon its host (Jeffreys). The species of Perthostoma, an American aquatic hemipterous insect, eat large quantities of Limnæa, Physa and Planorbis, which they hold with the fore-legs by folding between the thighs and tibiæ; even the larva of this insect, shortly after escaping from the egg, will seize and devour one of these mollusks with as much ease as if schooled in the process a long time (Leidy). Mollusks even fall a prey to animals much their inferiors in sagacity. Thus the star-fish swallows

* Bull. Ann. Mal. Belgique, xii, 23.

small bivalves entire (Donax, Mactra, Cardium), and dissolves the animal out of its shell; the digestive cavity of the Actinias nearly always contains gastropods (Bulla, Nassa, Trochus, Rissoa, etc).

A number of other animals live parasitic upon mollusks. There are several crustacean parasites of Doris; the lamellibranchiates are frequently infested with the Pinnotheres; a little crab of this genus is frequently found enclosed in the valves of the American oyster; the marine mussel (Mytilus) often nourishes a similar guest; *Ostracotheres Tridacnæ* takes hold of the branchiæ of Tridacna (Rüppell), and a little brachyurous crustacean, of a brilliant blue color, is nearly always found attached to the raft of Ianthina.

Pulmoniferous gastropods are infested by little acarides. The *Philodromus limacum* lives in the pulmonary chamber of European limaces and snails; and a similar species, *Hypopus concolor*, Hald., is found abundantly upon American Helices. But the Vermes furnish the largest contingent of parasites on Mollusks: unfortunately for science, we scarcely know anything concerning the cycle of their migrations. The following example will serve to show the interest attending such researches: The sporocysts or germinative sacs of *Distoma retusum* produce, in the Limnæans, the Cercariæ, or tailed larva, without genital organs. These Cercariæ are encysted in the interior of neuropterous larva. Finally they complete the cycle of their transformations in the frog, where under the form Distoma they acquire sexual organs. Several other forms, larval in aquatic mollusca, and perfect in frogs and aquatic birds, are known to science.

Aspidogaster conchicola lives in colonies in the pericardium of Unio and Anodonta, and *Cotylaspis insignis* occurs in the upper branchial cavity of the latter genus (Leidy). The *Paludina vivipara* of Europe nourishes no less than eight species of minute parasites. Prof. Haldeman, and others, have described several parasites upon American fresh-water mollusks; among them is *Anoplophrya vermicularis*, which Dr. Leidy observed in the intestine of *Paludina decisa*, sometimes so abundant as to distend the intestine.

Among terrestrial mollusks, Succinea lodges, in the interior of its tentacles, a sporocyst called *Leucochloridium paradoxum*, which is transformed in various birds into *Distoma macrostomum*. The tentacle thus occupied is swelled far beyond its usual size. Baudon states that the wagtail opens these tentacles for the purpose of eating the larva. Dujardin has seen several species of Distoma in the viscera of Helix and Limax.

The Trematodæ of marine mollusks are less known; they have been found in *Buccinum undatum* and *Littorina litorea*.

Nematoid worms are also parasitic in the Limaces. Some of the Hirudineæ attack shell-fish; Malacobdella lives upon Mya, Venus, Cyprina, Cytherea; Clepsina, Aulastomum, Nephelis, etc., attach themselves to the tissues of fresh-water mollusks. Dr. Leidy has recently described a larval *Distoma cornifrons*, found in the liver of *Donax fossor*, and which probably undergoes farther development in some of the shore birds or fishes which eat the Donax; the same mollusk also harbors the infusorian *Trichodina pediculus*.

Means of Defense. In no class is the instinct of self-preservation stronger, nor the means of defense more adequate than in the mollusca; their shells seem expressly given to compensate for the slowness of their movements, and the dimness of their senses. The cuttle-fish escapes from attack by swimming backwards and clouding the water with an inky discharge; and the sea-hare (Aplysia) pours out, when irritated, a copious purple fluid, formerly held to be poisonous. The purple fluid of the Murex, Purpura and Mitra, the whitish liquid produced by the marginal pores of Oncidiella, and the mucous secretion of terrestrial snails are all probably protectory in character. The dorsal papillæ of Æolis, carry at their extremity an urticating apparatus, consisting of a capsule, opening by an orifice, and containing some cellules, in the interior of which is enrolled a simple or barbed filament; this apparatus is analogous to those of the actiniæ and many of the cœlenterata.

The prick of the lingual teeth of some mollusks is poisonous. Captain Belcher was thus bitten by a Conus which he was handling, and the slight wound was followed by a very painful swelling. *Conus marmoreus* is considered a dangerous animal in New Caledonia; and accidents caused by the teeth of *Conus textile* are rather numerous in the New Hebrides (Montrouzier). Quoy and Gaimard have remarked that the lingual teeth of Cones are hollow, and provided with a sort of fish-hook at their free extremity; they are supposed to be detachable; and this hypothesis appears to be confirmed by the presence of a contraction near the insertion of the tooth on the lingual plate (x, 5).

Lamellibranchs and a large number of gastropods escape their enemies by the resemblance of the color and surface of their shell to their surroundings. Thus Patella and many other genera, are ordinarily covered with Balani and marine growths; others are hid under Bryozoa and encrusting sea-weeds, Serpulæ, Vermetidæ, Alcyonaria and Sponges; Xenophora solders shells and coral to its shell, or covers it with small pieces of stone, so that it looks like a small heap of dead shells or pebbles; the Poulpe (Octopus) shelters himself under the carapaces of crabs, or covers himself with bivalve shells; Lima forms a retreat in a

nest of interlaced byssiferous filaments containing fragments of shells, nullipores, etc. (Jeffreys).

Mimicry or adaptive coloration in the mollusca has been but little studied. Cephalopods are known to change their color to resemble the ground upon which they rest; and some of the gastropods living upon marine growths vary their colors according to that of their habitation. Lacuna, on the North Atlantic Coast of the United States, has a shell tinted conformably to the different species of Laminaria upon which it is found; and a little red Chiton lives on rocks carpeted with Algæ of the same hue (Morse).

It must be confessed that the instincts of the shell-fish are of a low order, being almost limited to self-preservation, the escape from danger, and the choice of food. An instance of something like social feeling has been observed in a Roman snail (*Helix pomatia*), which, after escaping from a garden, returned to it in quest of a fellow-prisoner; but the accomplished naturalist who witnessed the circumstance hesitated to record a thing so unexampled. The limpet, too, we learn from the observations of Mr. George Roberts, of Lyme Regis, is fond of home, or at least possesses a knowledge of topography, and returns to the same roost after an excursion with each tide. Professor Forbes has immortalized the sagacity of the razor-fish, which submits to be salted in its hole, rather than expose itself to be caught, after finding that the enemy is lying in wait for it. On the other hand, Mr. Bowerbank has a curious example of "instinct at fault," in the fossil spine of a sea-urchin, which appears to have been drilled by a carnivorous gastropod.

Monstrosities. We have already spoken of the various abnormal growths of shells; the unrolling of the spire, the reversal of its direction, etc., and the displacement of the organs caused by this latter frequently-occurring variation: it remains to mention a few of the less frequently observed instances of monstrous growth in other parts of the animal than those affected by its shelly covering. Fischer has seen a Subemarginula having two tentacles and two eyes on each side; and Bert records the case of a Patella in which those organs were doubled on one side only; bifid or forked tentacles are not rare among the Limnæans. The union of the long tentacles into a single one has been observed in Limax by Forbes and Hanley, and in Vitrina by l'Hôpital. Notwithstanding the coalescence of the tentacles, there were two eyes at the extremity. Double monsters have been frequently seen in the embryos of *Philine aperta*: they appear to be formed by the junction of two germs contained in the same shell.

Duration and Tenacity of Life. Not much is known respecting the individual duration of the shell-fish, though their length of

life must be very variable. Many of the aquatic species are annuals, fulfilling the cycle of their existence in a single year; whole races are entombed in the wintry tide of mud that grows from year to year in the beds of rivers, lakes and seas; thus, in the Wealden clay we find layer above layer of small river-snails, alternating with thin strata of sediment, the index of immeasurably distant years. Dredgers find that whilst the adults of some shell-fish can be taken at all seasons, others can be obtained adult in the autumn or winter only; those caught in spring and summer being young or half-grown; and it is a common remark that *dead* shells (of some species) can be obtained of a larger size than any that we find alive, because they obtain their full growth at a season when our researches are suspended. Some species require part of two years for their full development: the young of the Doris and Eolis are born in the summer time, in the warm shallows, near the shore; on the approach of winter they retire to deeper water, and in the following spring return to the tidal rocks, attain their full growth early in the summer, and after spawning-time disappear.

The land snails are mostly biennial; hatched in the summer and autumn, they are half-grown by the winter time, and acquire their full growth in the following spring or summer. In confinement, a garden-snail will live for six or eight years; but in their natural state it is probable that a great many die in their second winter, for clusters of empty shells may be found, adhering to one another, under ivied walls, and in other sheltered situations; the animals having perished in their hibernation. Some of the spiral sea-shells live a great many years, and tell their age in a very plain and interesting manner, by the number of fringes (*varices*) on their whorls; the contour of the Ranella and Murex depends on the regular recurrence of these ornaments which occur after the same intervals in well-fed individuals, as in their less fortunate kindred. The Ammonites appear by their *varices*, or periodic mouths, to have lived and continued growing for many years.

Many of the bivalves, like the mussel and cockle, attain their full growth in a year, but various facts show that the adult size can be attained within a shorter period. Thus, a ship just careened and freshly bottomed left Marseilles, and in 48 days arrived at the River Gambia, where it remained 68 days, and in 86 days additional made the return voyage: which had lasted in all 202 days. Arrived at Marseilles, *Mytilus afer*, *Avicula Atlantica* and *Ostrea denticulata*, fully grown, were found attached to its bottom. These three species belong to the African fauna, and thus had acquired their adult size within five months after the earliest period at which, as young shells, they could have attached themselves (Petit). Fischer states that in

1863 he collected *Mytilus edulis*, four inches in length, from a buoy at Arcachon, which had been cleaned under his eyes a year previously: in this case the species had grown to nearly double the size which it normally attains within the same period in the mussel-banks of this locality.

The oyster continues enlarging its shell by annual "shoots," for four or five years, and then ceases to grow outwards; but very aged specimens may be found, especially in a fossil state, with shells an inch or two in thickness, and very heavy. The giant-clam (Tridacna), which attains so large a size that poets and sculptors have made it the cradle of the sea-goddess, must enjoy an unusual longevity; living in the sheltered lagoons of coral islands, and not discursive in its habits, the corals grow up around until it is often nearly buried by them; but although there seems to be no limit to its life (it may live a century for all that we know), yet the time will probably come when it will be overgrown by its neighbors, or choked with sediment.

The Meleagrina or pearl-oyster of Ceylon lives seven or eight years (Tennent).

The fresh-water mollusks of cold climates bury themselves during winter in the mud of ponds and rivers; and the land snails hide themselves in the ground, or beneath moss and dead leaves. In warm climates they become torpid during the hottest and driest part of the year. Among those which are inoperculated, the mantle at this time secretes a temporary door to the aperture, which is sometimes glutinous (Orthalicus), sometimes thin, like a lamina of isinglass, sometimes calcareous and thickened (*Helix pomatia*, *H. naticoides*, etc.). Occasionally, besides this calcareous plate, there are found one or several membranaceous epiphragms farther within the aperture.

Those genera and species which are most subject to this "summer sleep" are remarkable for their tenacity of life; and numerous instances have been recorded of their importation from distant countries in a living state. In June, 1850, a living pond-mussel was sent to Dr. Gray from Australia, which had been more than a year out of water. In December, 1874, Deshayes, in opening a box of Anodontas, collected eight months previously by the naturalists of the French expedition to Cambodia, found two individuals still living within their paper coverings. He has given to this species the name of "*Anodonta semperverens*." The pond-snails (Ampullariæ) have been found alive in logs of mahogany from Honduras (Mr. Pickering); and M. Cailliaud carried some from Egypt to Paris packed in saw-dust. Indeed, it is not easy to ascertain the limit of their endurance; for Mr. Laidlay having placed a number in a drawer for this purpose, found them alive after *five years*, although in the warm climate of Calcutta. The Cyclostomas, which are also

operculated, are well known to survive imprisonments of many months; but in the ordinary land-snails such cases are more remarkable. Some of the large tropical Bulimi, brought by Lieutenant Graves from Valparaiso, revived after being packed, some for thirteen, others for twenty months. In 1849, Mr. Pickering received from Mr. Wollaston a basket-full of Madeira snails (of twenty or thirty different species), three-fourths of which proved to be alive after several months' confinement, including a sea voyage. Mr. Wollaston has himself told us that specimens of two Madeira snails (*Helix papilio* and *tectiformis*) survived a fast and imprisonment in pill-boxes of two years and a half, and that a large number of the small *Helix turricula*, brought to England at the same time, were all living after having been enclosed in a dry bag for a year and a half.

Mr. Crosse has kept alive without nourishment, for more than two years, several specimens of *Helix signata* of Rome; and R. E. C. Stearns mentions a *Helix Veatchii* from Cerros Island, Lower California, which passed six years, from 1859 to 1865, without food.

This relaxation of the principal vital functions, will even, in certain cases influence reproduction. Gaskoin cites the case of a *Helix lactea*, obtained of a Mogador merchant in April, 1849, which had been kept for two years in a drawer, exposed to a dry atmosphere and dust. This isolated Helix laid thirty eggs in October, 1849, which attained their full size in less than a year. It could be objected to the opinion of Gaskoin, who considered this fact as proving an arrest of gestation, that parthenogenesis or fecundation *in situ*, is possible in the Helices, the genital gland including both male and female elements.

But the most interesting example of resuscitation occurred to a specimen of the Desert-snail, from Egypt, chronicled by Dr. Baird. This individual was fixed to a tablet in the British Museum on the 25th of March, 1846; and on the 7th of March, 1850, it was observed that he must have come out of his shell in the interval (as the paper had been discolored, apparently in his attempt to get away); but finding escape impossible, had again retired, closing his aperture with the usual glistening film; this led to his immersion in tepid water and marvelous recovery.

The small effect which extremes of temperature has upon mollusks assures their conservation. Anodontas and Paludinas survive freezing, and will reproduce after being thawed (Joly). *Unio Requieni* lives in the thermal waters of Barbotan (France), the temperature of which is 86 degrees, in company with *Limnæa peregra* and *Physa acuta*. Analogous cases are recorded. Near Bona, Algeria, a Hydrobia lives in a thermal spring, the temperature of which is 108 degrees. *Planorbis Oregonensis*, Tryon,

was collected by the late W. M. Gabb in a thermal spring in the Pueblo Valley, Oregon, the temperature of the water being above blood heat. Limnæa, Anodonta and Neritina, are able to endure water slightly brackish; *Physa d'Orbignyana*, Lea, lives in the salt marshes at Monterey, California; and Pholas, Teredo, oysters, Arca and Modiola accommodate themselves to the fresh-water streams of Asia and Malaysia. On the other hand the numerous species of fresh-water Melanians of the Southern rivers of the United States, seem to be arrested in their distribution by the slightest admixture of sea-water, and do not approach the coast. A little Limnæa (*L. peregra*, var. *geisericola*) lives in the waters of the Geysers of Iceland (Mörch). The admixture of sulphurous and ferruginous elements in the streams does not seem to prevent the multiplication of some mollusks. *Cardium edule* has become extinct in the *Chotts* of Algiers and Tunis, on account of excess of brine, although a marine species; yet the fresh-water genera Melania and Melanopsis have been collected from waters surcharged with salt so as to be absolutely undrinkable, at the oasis of Ouargla, south of Algeria (Tournouër).

The permanency of the shell-bearing races is effectually provided for by their extreme fecundity; and though exposed to a hundred dangers in their early life, enough survive to re-people the land and sea abundantly. The mollusca exhibit the same instinctive care with insects and the higher animals in placing their eggs in situations where they will be safe from injury, or open to the influences of air and heat, or surrounded by the food which the young will require.

"If any one imbued with the spirit of Paley or Chateaubriand, should study these phenomena, he might discover more than the 'barren facts' which alone appear without significance to the unspiritual eye; he would see at every step fresh proofs of the wisdom and goodness of God, who thus manifests His greatness by displaying the same care for the maintenance of His feeblest creatures as for the well-being of man and the stability of the world."—WOODWARD.

Economic Uses of Shells. We have spoken of shell-fish as articles of food, but shells have other uses even to man; they are the toys of children, who hear in them the roaring of the sea; they are the pride of "collectors"—whose wealth is in a cone or "wentle-trap;" and they are the ornaments of barbarous tribes. The Friendly Islander wears the orange-cowry as a mark of chieftainship (Stutchbury), and it is somewhat rare to find a specimen in collections which has not been bored through the back for the purpose of suspending it; and the New Zealander polishes the Elenchus into an ornament more brilliant than the "pearl ear-drops" of classical or modern times (Clarke).

Other Oceanic tribes ornament their pirogues with the Ovula; and *O. angulosa* is so much esteemed by the natives of the New Hebrides that they will give in exchange for it a half ton of sandal-wood, worth four or five hundred francs (Montrouzier). The taste for shell ornaments has been exhibited by man since a very early period of his history, for the caverns of Europe contain both living and fossil species of shells, frequently pierced, and in intimate connection with undoubted remains of the stone age; the mound-builders of America likewise buried these with their dead along with other treasures, ornaments and implements. Leidy has recently found a Conus, a species inhabiting the west coast of Central America, among flint implements and numerous remains of living and extinct animals, in a cavern near Stroudsburg, Pennsylvania. The Troglodyte of Mentone, discovered by Rivière, the skeleton of which is preserved in the Museum of Paris, appears to have worn a coiffure ornamented with pierced shells of *Cyclonassa neritea*.

Shells serve as money in various parts of the world. In Africa, *Cypræa moneta*, the money-cowry has a fixed value in commercial transactions; *Dentalium pretiosum* and *Oliva biplicata* are standards of value among the Indians of the west coast of North America; *Littorina obesa* and *Nerita polita* are current in some of the Indo-Pacific Islands.

Fragments of the shells of *Venus mercenaria* (clam) were pierced and strung by the Indians of the Atlantic coast of the United States, forming their strings of Wampum or shell money; these were current among them for a considerable period after the advent of white settlers. Pieces of Saxidomus and Haliotis are similarly used by the natives of California (Stearns). The same usage prevails in Benguella. The shell of a terrestrial mollusk (*Achatina monetaria*) cut into circles, with an open centre is the monetary sign employed in commerce, and in payment of a part of the tribute. They are formed into chaplets called *Quirandas de dongo*, which serve also as ornaments for the ladies (Morelet). Even in the prehistoric grottoes of Europe have been collected pierced fragments of *Cardium edule*, which were probably used as "wampum" by the rude people who resorted to such localities.

One of the most beautiful substances in nature is the shell-opal, formed of the remains of the Ammonite. The forms and colors of shells (as of all other natural objects), answer some particular purpose, or obey some general law; but besides this, there is much that seems specially intended for our study, and calculated to call forth enlightened admiration. Thus the tints of many shells are concealed during life by a dull external coat, and the pearly halls of the Nautilus are seen by no other eyes than ours. Or descending to mere utility, how many tracts of

coast are destitute of limestone, but abound in shell-banks which may be burned into lime; or in shell-sand, for the use of farmers.

The taste for collecting shells and competition among collectors have caused some of the rarer species to be valued at extraordinary prices, which usually tend to diminish as the formerly little-frequented regions which they inhabit become better explored. The extravagant rates that have been given for rare shells are less to be regretted, since they have induced voyagers to collect them. Mere shell-collecting, however, is no more scientific than pigeon-fancying, or the study of old china.' For educational purposes the best shells are the *types* of genera, those which illustrate particular points of structure; and, fortunately for students, excellent generic suites can be obtained for very reasonable prices. Not only have well-named private collections largely increased in number during late years, but almost every college museum includes what would formerly have been considered a large conchological cabinet. The three largest conchological collections in the world are those of the Academy of Natural Sciences of Philadelphia, the British Museum, and the Museum of Natural History at Paris. The first-named includes about 140,000 specimens, all mounted and labeled, contained in about 35,000 trays; its geographical suites are the most extensive known. The British Museum collection is about half or less than half as large as that of the Philadelphia Academy, but contains many more specific types, inasmuch as it includes the famous Cumingian Collection. A large majority of these types are not good species; nevertheless they have a value as evidence that their described distinctive characters are valueless.* The Paris collection is, perhaps, the smallest, but its

* "No one knew better than Mr. Cuming the value of a new name to his specimens, as shown by his enmity to any one who doubted the novelty of the species described. He would not allow me to see his collection for many years after his return from South America, because I had pointed out to him at one of the meetings of this society that some of the shells which Messrs. Sowerby and Broderip had described as new were well-known species, and well figured by Chemnitz." "Since that period Mr. Cuming refused a well known conchologist, who had previously described several shells from his cabinet, any further use of his collection, because he refused to admit that certain specimens which he sent to him to be described were new to science, or different from species already described. The system that Mr. Cuming adopted of selecting three specimens of each variety or species most alike, tended to prevent the number of nominal or presumed species from being observed during a casual examination of the collection, as it excluded those specimens which showed the transition from one variety to another, which occurs in any given species—more especially as the species were not arranged in the drawers so that the most allied of presumed species were near to each other, but, on the contrary, they * * * were often placed in distant parts of the series." – Dr. J. E. GRAY, *Zool Proc.*, 729, 1867.

arrangement is admirable; moreover it contains a host of species collected by the numerous French Exploring Expeditions—species very imperfectly represented elsewhere.

Some information concerning "fancy" prices paid for shells may be of interest. *Scalaria pretiosa*, which can now be had for one or two dollars, was worth $100 in 1735 and $200 in 1701. *Phasianella bulimoides*, which also brought $100, can now be purchased at from one to two dollars, or even less. In 1865 a great English collection, that of Dennison, was sold by auction, in London, and some extravagant prices realized. *Cypræa guttata* brought $200; *Cypræa princeps*, the same; *Conus gloriamaris*, also $200; *Conus cervus*, nearly $90; *Conus cedo-nulli* (not a very rare shell), $90 and $110; *Conus omaicus* (also not rare), $60; *Voluta festiva*, $80; *Oniscia Dennisoni*, $90; *Pholadomya candida*, $65 (several fine specimens in the Philadelphia Collection); *Carinaria vitrea* (which Montfort stated to be worth $600) brought $50. The very rare *Pleurotomaria Quoyana* brought in London, in 1872, $125. In 1876 the Rœters van Lennep collection was sold, including: *Voluta Junonia*, $50; *Mitra Belcheri*, $40; *Spondylus regius*, $36, etc. For this same *Spondylus regius* Professor Richard had previously paid several thousand francs. *Voluta Junonia* has always been considered a rare species, and dealers have obtained as much as forty pounds sterling for it. They still ask large prices for it, although a number of specimens are obtained yearly by dredging or otherwise, and they can generally be bought from first hands at from six dollars to twelve dollars each. *Cypræa umbilicata* has been sold for thirty pounds, and may now be had for one pound. The Boston Society of Natural History possesses an *Argonauta argo* or Paper Nautilus shell, which is said to have been purchased by the gentleman who presented it to that Society for $500. It is a common species, and the only reason for the great valuation of this specimen, is that its diameter is about two or three inches greater than any other individual known to naturalists.

For scientific purposes common shells are quite as good as rare ones, and the price demanded for a single rarity will generally suffice for the purchase of many species of more frequent occurrence. Lovers of the beautiful are certainly justified in acquiring preferentially, fine specimens for their cabinets, but the too frequent custom of paying high prices for presumed novelties has led to much abuse in the description of new species. I cannot better illustrate this fact than by citing again from Dr. Gray's paper on the Cumingian Collection, published in the Zoological Proceedings, London, 1867:

"A very large number of species in the collection have been separated on very slight characters, or on the slightest variation of form, state, and color. This has greatly arisen from the

description and figuring of shells lately made known chiefly falling into the hands of dealers, * * * or of persons employed by dealers, who select for their purpose those who are ready to fall into their views and make as many new species as possible. * * * A shell with a new name is much more valuable in a pecuniary point of view than one with an old and well-known name. The value dealers attach to new names is proved by an incident that occurred to myself a few days ago, when a dealer offered me a new Volute for ten guineas. I said it was not new, only a slight variety of a well-known species. At length he admitted that he had nine specimens of the Volute, and ended by offering to present me with the best of the series if I would describe it as a new species. I am told that at length he found a person to fall into his views, and sold all his specimens at or above the price first mentioned."

GEOGRAPHICAL DISTRIBUTION OF THE MOLLUSCA.

Living beings are not distributed at hazard through the depths of the waters and over the surface of the earth, but each species occupies a determined area and has a distinct geographical distribution. In searching for the causes of this law, physical conditions have been first thought of; time, also, is one of the greatest factors, evidently; and the laws of variation or adaptability, as yet so little understood, will serve to cast much light on the problem: but after all these factors and all the deducible consequences are fully before us there is still the great question of origin to be considered; and for this we are forced to accept one of two pure hypotheses: either that centres of creation exist by God's will and independent of physical conditions, or that diverse beings, however isolated in distribution, are all the descendants of a common ancestral type, and have therefore probably been derived from a unique creation. The latter hypothesis is the most fashionable at present, because in this age man observes rather than marvels, and it is more satisfactory to the human mind to be able to account for things being as we find them than to refer their existence to the more or less immediate intervention of an unknown and unknowable power. Perhaps the development theory has done more to give us a truly philosophical view of nature than any other hypothesis has ever done, but there can be no doubt that many of its principal advocates have allowed their judgment to become dazzled by its very brilliancy, and in accepting as facts merely speculative propositions, have discovered an amount of credulity quite equal

to that of the most conservative of their opponents. I should write this book to little purpose, if I should not be able to indicate the identity of origin of many so-called distinct genera or species, and that in these cases, at least, physical causes have been amply sufficient first to produce and then to maintain diversity; but the proposition that therefore derivation must account for really important existing structural differences, receives little or no support from actual observation, so far as the mollusca are concerned.

The older authors, and those who still accept the idea that species are the result of the special intervention of Divine Will, have assigned to the genera and species of animals definite areas of distribution, and which are supposed to be more or less independent of physical causes. The occurrence of similar forms in distinct areas, they will not admit as conclusive of their common ancestry, but prefer to call them "representative species" and to marvel that separately created beings (therefore different species) should so closely resemble one another. I will here say plainly, as a result of many years' study of the geographical distribution of the mollusca, that defined limits to the so-called "Provinces" do not exist in nature except where these provinces have been fixed by physical causes alone; that whatever or wherever may have been the origin of the various genera or species, physical causes always sufficed to account for their subsequent distribution. I accept the existence of a species where theoretically it has no business to exist as proof that something is amiss with the theory. Geographical provinces of distribution having necessarily been determined through observation of the species composing them, when more extended observation modifies our knowledge, so should our boundaries vary. To illustrate: it was supposed that most of the shells inhabiting the Atlantic Coast of the United States, north of Cape Cod, were divided by it from those living southwards of that peninsula, and Cape Cod was accordingly made the boundary between two marine provinces; yet the multiplied researches of modern naturalists have shown and are showing that under like physical conditions neither northern nor southern species hesitate to cross the line which the closet-naturalist has forbidden them to cross. Deepsea dredgings also inform us that some Arctic mollusca are quite willing to extend southwards where the surface temperature would forbid their habitation, provided that at a greater depth they can secure climatal influences similar to the shore lines of the northern waters.

In most cases Provinces of Distribution or Areas of Assemblage of species *are* physically defined, in fact, although they have been so frequently somewhat arbitrarily constituted: yet we must carefully recognize the distinction between an assem-

blage or congeries of species as evidence of the existence favoring conditions, and the inference that therefore tho species are to be found nowhere else. It was thought that th conditions which prevented the Neptuneas of the boreal se from extending southwards of Cape Cod, also would preve the extension southwards of the equally boreal genus Buccinu yet a typical species of the latter genus has far overstepped th boundary; and many species go wandering about the world li knights-errant, challenging the theorists—who invariably decli the issue on the ground that finding them where they have n business to be is sufficient proof that they are not themselve

In order to constitute a distinct province it is considere necessary that at least *one-half* the species should be *peculiar*, rule which applies equally to plants and animals. Some gene and subgenera are limited to each province, but the proportio is different in each class of animals and in plants.

Specific Areas. Species vary extremely in their range, som being limited to small areas, while others, more widely diffuse unite the local populations into fewer and larger group Those species which characterize particular regions are terme "endemic;" they mostly require peculiar circumstances, c possess small means of migrating. The others, sometimes calle "sporadic," possess great facilities for diffusion, like the lowe orders of plants propagated by *spores*, and more easily meet wit suitable conditions. The space over which a species is distribute is called a "centre," or, more properly, a specific *area*. Th areas of one-half the species are smaller (usually much smalle than a single province.

In each specific area there is frequently one spot whe individuals are more abundant than elsewhere; this has bee called the "metropolis" of the species. Some species whic appear to be nowhere common can be shown to have abounde formerly; and many probably seem rare only because the headquarters are at present unknown.—(FORBES.)

Specific Centres are the points at which the particular speci are supposed to have been created, according to those wh believe that each has originated from a common stock; thes can only be known approximately in any case. The doctrin that each species originated from a single individual, or pair created once only, and at one place, derives strong confirmatio from the fact that so "many animals and plants are indigenou only in determinate spots, while a thousand others might hav supported them as well."

Boundaries of Natural History Provinces. The land province are separated by lofty mountains, deserts, seas, and climates whilst the seas are divided by continents and influenced by th physical character of coast-lines, by climates and currents

These "natural barriers," as they were called by Buffon, retard or altogether prevent the migrations of species in particular directions.

I am about to speak in detail of geographical provinces; but as I do not regard them from the same point of view as some of my predecessors, I have deemed it inadvisable to occupy as much space in the discussion as Woodward, for instance, has done. In fact, except where provinces are physically circumscribed, as an isolated island, for instance, their boundaries are more artificial than natural, and might, in many cases, be greatly changed without depriving them of that measure of exclusiveness which is held to constitute a distinct fauna. As to the distribution of the species, if we take a hundred species of the Panamic Province or Region, for instance, we shall find that we have a hundred areas of distribution, and no determinate specific centre. If, instead of the present divisions of Aleutian, Californian, Panamic and Peruvian Provinces, we should locate provinces of equal geographical extent *anywhere* on the coast, we should find as many species peculiar to them as to the former.

Granted that geographical provinces or regions do not fulfill the ideas which they were originally intended to convey, they are still useful (as many other partly artificial systems are useful), in recalling the character of the fauna of a given section of the world by means of a name. To subserve this purpose, it is advisable that the names and boundaries should not be subject to change, just as it is advisable not to change the name of a genus or species; I therefore, present the various provinces as they have been generally accepted, without reference to their varying values. Pelagic mollusks (cephalopods, pteropods, heteropods), have the most extended distribution, and, of course, cannot be considered properly as belonging to any particular faunal regions. The same may be remarked of deep-sea species, as the conditions under which they exist are altogether different from those which determine the distribution of littoral species. The latter only are taken into consideration in forming marine provinces.

Amongst the genera of marine shells there are some which have been considered particularly indicative of climate. From the Arctic list the following may be taken as examples of the shells of high latitudes; those marked * being found in the southern as well as in the northern hemisphere :—

Buccinum,	*Trichotropis,	*Rhynchonella,	*Astarte,
*Chrysodomus,	Velutina,	*Crenella	Cyprina,
*Trophon,	Lacuna,	Yoldia,	Glycimeris.
Admete,	*Margarita,		

The following have been thought peculiar to the warı regions of the sea:

Nautilus,	Conus,	Columbella,	Perna,
Rostellaria,	Harpa,	Cypræa,	Vulsella,
Triton,	Oliva,	Nerita,	Tridacna,
Cancellaria,	Voluta,	Spondylus,	Crassatella,
Terebra,	Marginella,	Plicatula,	Sanguinolaria

But it must not be inferred that these genera had always tl present distribution. On the contrary, nearly the whole of tl have existed in the British and American seas at no very ren geological period. *Rhynchonella* and *Astarte* were form "tropical shells;" and since the period of the English ch formation there have been living *Nautili* in the North Sea, Cones and Olives in the "London basin."

The tropical and subtropical provinces might be natur grouped in three principal divisions, viz., the Atlantic, the Iı Pacific, and the West American—divisions which are boun by meridians of longitude, not by parallels of latitude. ' Arctic province is comparatively small and exceptional; the three most southern Faunas of America, Africa, and Austr differ extremely, but not on account of climate.

If only a small extent of sea-coast is examined, the chara of its mollusca will be found to depend very much upon nature of the shore, the tides, depth, and local circumstan but these peculiarities will disappear when the survey is exten to a region sufficiently large to include every ordinary vari of condition.

It has been stated that each fauna consists of a number of p liar species, properly, more than half; and of a smaller num which are common to some other provinces. By ascertair the direction of the tides and currents, and the circumsta under which the species occur, it may be possible to determin which province these more widely diffused mollusca origin belonged. And when species occur both recent and fossil i easy to perceive the direction in which their migrations h taken place. The fauna of the Mediterranean has been critic examined by Prof. Forbes and M. Philippi, with this resul that a large proportion of its population has migrated int from the Atlantic, and a smaller number from the Red Sea, that the supposed peculiar species are diminishing so rapi with every new research in the Atlantic, that it can no lor rank as a province distinct from the Lusitanian.

MARINE PROVINCES.

There are eighteen Marine Provinces:

1, Arctic; 2, Boreal; 3, Celtic; 4, Lusitanian; 5, Ar Caspian; 6, West African; 7, South African; 8, Indo-Paci

istralo-Zealandic; 10, Japonic; 11, Aleutian; 12, Califor-; 13, Panamic; 14, Peruvian; 15, Magellanic; 16, Pata-a; 17, Caribbean; 18, Transatlantic.

I. *Arctic Province.*

North Polar Seas contain but one assemblage of Mollusca, Southern limit is formed by the Aleutian Islands in the , but in the North Atlantic is determined chiefly by the ary of floating ice, descending as low as Newfoundland West, and thence rising rapidly to Iceland and the North The existence of the same marine animals in the Kam-Sea and Baffin's Bay was long since held to prove at former Northwest passage; but the occurrence of recent ls in banks far inland rendered it probable that even levation of the land in Arctic America might have much the passage. During the "Glacial period," this Arctic h the same fauna, extended over Britain; over Northern , as far as the Alps and Carpathians; and over Siberia, considerable part of North America. The shells now n the Arctic Seas, are found fossil in the deposits of ern Drift," over all these countries; and a few of the yet linger within the bounds of the two next provinces, ly in tracts of unusual depth. The Arctic shells have thick epidermis and but little color; they occur in very undance, and are remarkably subject to variation of form; stance attributed by Professor E. Forbes to the influence nixture of fresh water produced by the melting of great f snow and ice.

II. *Boreal Province.*

Boreal Province extends across the Atlantic from Nova and Massachusetts to Iceland, the Faroe and Shetland and along the coast of Norway from North Cape to the includes Iceland except its northern coast. Its Southern an boundary is Cape Cod.

9 Scandinavian shells catalogued by Dr. Lovén, 217, or ent. are common to Britain, and 137 range as far as the oast of Spain.

oreal shells of America are catalogued by Dr. Gould; hose lists it appears that out of 270 sea-shells found on st of Massachusetts north of Cape Cod, more than half mon to Northern Europe.

of the species, it is believed, could only have extended nge so distantly by means of continuous lines of con-coast, now no longer in existence.

province is very poorly defined: a large portion of the

Arctic mollusca are or have been residents, whilst many of the species originating within its boundaries extend further southwards.

III. *Celtic Province.*

The Celtic Province, as described by Prof. E. Forbes, includes the British island coasts, Denmark, Sweden, and the coasts of the North Sea and Baltic. The fauna of this region (which includes the principal herring fisheries) is essentially Atlantic; many of the species are of ancient origin and occur fossil in the Pliocene.

Fischer admits that this province does not fulfill the zoological conditions, as it contains too large a proportion of boreal species, and very few peculiar to its region.

The British marine mollusca described by Forbes and Hanley amount to nearly 500 species.

Of this number two-thirds of the Nudibranchiata, and a few marine univalves, and bivalve shell-fish, are, at present, only known in British seas; but as most of these are minute or "critical" species, it is considered they will yet be met with elsewhere.

A few of the species belong to the Lusitanian province, whose northern limits include the Channel Islands, and just impinge upon the English coast. They appear mostly to have emigrated northwards after the glacial epoch, as they are not included in the Crag mollusca.

Of the Gastropoda 54 are common to the seas both north and south of Britain; 52 range farther south, but are not found northward of those islands; and 34 which find here their southern limit occur not only in Northern Europe, but most of them in Boreal America. Nearly half of the bivalves range both north and south of Britain; 40 extend southward only, and about as many more are found in Scandinavia, 27 of them being common to North America. (FORBES.)

According to Mr. M'Andrew's estimate in 1850, 406 British shell-bearing mollusca were then known, of which

217 or 53	per cent.	were common to	Scandinavia.
246 or 61	"	"	North of Spain.
227 or 56	"	"	S. Spain and Medit.
97 or 24	"	"	Canary Islands.

The wide expanse of the Baltic affords no shell-fish unknown to the coasts of Britain and Sweden. The water is brackish, becoming less salt northward, till only estuary shells are met with, and the Littorinæ and Limnæans are found living together, as in many of the British marshes.

IV. *Lusitanian Province.*

The Atlantic shores of France, Spain, Portugal, the Mediterranean, Black Sea, and N. W. Africa, as far as Cape Juby, form an important province, extending westward in the Atlantic as far as the Gulf-weed banks, so as to include Madeira, the Azores, and Canary Islands.

In the Atlantic portion of the province occur the following genera, not met with in the Celtic and Boreal seas, although two of them, *Mitra* and *Mesalia*, occur on the coast of Greenland:—

Argonauta.	Cancellaria.	Auricula.	——
Philonexis.	Sigaretus.	Pedipes.	Spondylus.
Chiroteuthis.	Crepidula.	Ringicula.	Avicula.
——	Mesalia.	Umbrella.	Solemya.
Conus.	Vermetus.	Glaucus.	Chama.
Pleurotoma.	Fossarus.	——	Crassatella.
Marginella.	Planaxis.	Carinaria.	Lithodomus.
Cymba.	Litiopa.	Firola.	Ungulina.
Mitra.	Truncatella.	Atlanta.	Galeomma.
Terebra.	Solarium.	Oxygyrus.	Cardita.
Columbella.	Bifrontia.	——	Cytherea.
Pisania.	Turbo.	Cleodora.	Petricola.
Dolium.	Monodonta.	Cuvieria.	Venerupis.
Cassis.	Haliotis.	Creseis.	Mesodesma.
Triton.	Gadinia.	——	Ervilia.
Ranella.	Siphonaria.	Megerlia.	Panopæa.

The great depth of the Gulf of Gascony has favored the introduction of some boreal mollusks; on the other hand, a few African genera extend into the Mediterranean.

France. Fischer catalogued in 1878, 569 species. Of these 336 are common to Great Britain and the Mediterranean; 91 are common to Great Britain, but not in the Mediterranean; 82 are common to the latter and not to the former; and 60 appear to be peculiar to the coast of France.

Spain and Portugal. These coasts are less known than any other part of the province, but the facilities for exploration are in some respects greater than in the Mediterranean, on account of the tides. Shell-fish are much in demand as an article of food, and the Lisbon market afforded to Mr. M'Andrew the first indication that the genus Cymba ranged so far north.

On the coasts of the Asturias and Gallicia, especially in Vigo Bay, Mr. M'Andrew obtained, by dredging, 212 species, of a somewhat northern character, 50 per cent. of them being common to Norway, and 86 per cent. common to the south of Spain.

On the southern coast of the Peninsula 353 species were obtained, of which only 28 per cent. are common to Norway and 51 per cent. to Britain.

The identical species are chiefly amongst the shells dredged from a considerable depth (35–50 fathoms); the littoral species have a much more distinct aspect.

The shells of the coast of Mogador are generally identical with those of the Mediterranean and Southern Peninsula.

Canary Islands. The shells of the Canaries collected by MM. Webb and Berthelot, and described by M. d'Orbigny, amount to 124, to which Mr. M'Andrew has added above 170. Of the 300 species 17 per cent. are common to Norway, 32 per cent. to Britain, and 63 per cent. to the coasts of Spain and the Mediterranean. Two only are W. Indian shells, *Neritina viridis* and *Columbella cribraria.* Of the African shells found here, and not met with in more northern localities, the most remarkable are:—

Crassatella divaricata.	Ranella lævigata.	Cymba proboscidalis.
Cardium costatum.	Cassis flammea.	Conus betulinus.
Lucina Adansoni.	" testiculus.	" Prometheus.
Cerithium nodulosum.	Cymba Neptuni.	" Guinaicus.
Murex saxatilis.	" porcina.	" papilionaceus.

Madeira. Mr. M'Andrew obtained 156 species at Madeira, of which 44 per cent. are British, 70 per cent. common to the Mediterranean, and 83 to the Canaries. Amongst the latter are the two W. Indian shells before mentioned, and the following African shells:—

Pedipes.	Mitra fusca.	Patella crenata.
Littorina striata.	" zebrina.	" guttata.
Solarium.	Marginella guancha.	" Lowei.
Scalaria cochlea.	Cancellaria.	" Candei.
Natica porcellana.	Monodonta Bertheloti.	Pecten corallinoides.

Azores. Amongst the littoral shells which range to the Azores, are Pedipes, *Littorina striata*, *Mitra fusca*, and *Ervilia castanea;* the other species obtained there are Lusitanian. (M'Andrew).

The Mediterranean is the richest conchological fauna of temperate seas. In its western part it is mostly identical with that of the adjacent Atlantic coasts; the number of species diminishes eastward, although reinforced by a considerable number of new forms as yet only known in the Mediterranean; and three accessions of a different character, from the Red Sea. The total number of species is 1183, according to Monterosato and Fischer.

Cephalopoda,	53	Scaphopoda,	15	Lamellibranchiata,	302
Pteropoda,	19	Gastropoda,	782	Brachiopoda,	12

This enumeration includes the deep-sea dredgings of the Porcupine Expedition.

The Mediterranean fauna appears to be perfectly homogeneous; but a few African forms enter the Straits of Gibraltar, and are found on the adjacent coasts of Spain and Algiers. The most peculiar of these species is the large *Cymbium olla*, belonging to the family Volutidæ.

In the Bay of Cadiz, just without the Strait of Gibraltar lives the *Halia priamus*, the only representative of its genus. Its position in the system has been often changed, and it is only within late years that the animal has been obtained and its relationships understood. It is extinct in the Mediterranean, but fossil in the pliocene of the North of Italy. *Ungulina rubra*, of Senegal, has likewise been collected at Cadiz. *Strombus bubonius* of Senegal is found fossilized in the latest deposits of the newer pliocene.

The study of the miocene and pliocene tertiary fauna of the Mediterranean Countries shows that this Sea has received accessions belonging to the Indian Ocean, West Africa and North Europe. These tertiary fossils appear to indicate a much warmer sea, in which Polyps lived. Consequent upon its refrigeration and the interruption of the communication with the Indian Ocean, a number of these genera became extinct at the commencement of the pliocene epoch, although a few representatives of a more tropical fauna still survive. The following may be cited:

(*A*, *African*; *O*, *Indian Ocean*).

Umbrella, O.	Fasciolaria, A.	Mesalia, A.
Marginella, A.	Cancellaria, A.	Clavagella, O.
Cymbium, A.	Pedicularia, O.	Cardita, A. O.
Clanculus, A. O.	Sigaretus, A.	Chama, A. O.
Xenophora, A. O.	Siliquaria, A.	Spondylus, A. O.
Typhis, A. O.		

Finally the Mediterranean genera Crepidula, Smaragdia, Dolium, Rissoina, Solemya, Thecidium, are identical with American forms belonging to the Transatlantic and Caribbean Provinces.

Black Sea. In the northern part a few Aralo-Caspian shells are found, otherwise the Black Sea only differs from the Mediterranean in the paucity of its species; Dr. Middendorff enumerates 68 only. The water is less salt, and there is no tide, but a current flows constantly through the Dardanelles to the Mediterranean.

Gulf-weed Banks. The few species collected are principally pelagic, consisting of nudibranchiates, Litiopa, etc. Two species of Patellidæ are the only mollusks in common with Europe and there is no good reason why this fauna should be included in the Lusitanian Province.

V. *Aralo-Caspian Province.*

The only inland salt-seas that contain peculiar shell-fish are the Aral and Caspian. The shells chiefly consist of a remarkable group of Cockles (Cardium), which burrow in the mud. No explorations have been made with the dredge, but other species, probably still existing in these seas, have been found in the beds of horizontal limestone which form their banks and extend in all directions far over the *steppes*. This limestone is of brackish-water origin, being sometimes composed of myriads of Cyclades, or the shells of Dreissena and Cardium, as in the islets near Astrakhan. It is believed to indicate the former existence of a great inland sea, of which the Aral and Caspian are remnants, but which was larger than the present Mediterranean at an age previous to that of the Mammoth and Siberian Rhinoceros. The present level of the Caspian is 83 feet below that of the Black Sea; that of the Aral has been stated to be 117 feet higher than the Caspian, but is probably not very different; their waters are only brackish, and in some parts drinkable. The steppe limestone rises to a level of 200–300 feet above the Caspian; it spreads eastward to the mountains of the Hindoo Kush and Chinese Tartary, southward over Daghestan and the low region E. of Tiflis, and westward to the northern shores of the Black Sea. The extent to which it has been traced is represented by oblique lines on the map. Some of the Caspian shells still exist in the Sea of Azof and the estuaries of the Dnieper and Dniester.

Few other inland bodies of brackish water are known to have peculiar shells; those of the modern deposits, in Mesopotamia (at Sinkra and Warka), collected by Mr. W. K. Loftus, are species still abounding in the Persian Gulf. All the living shells of this Province are of estuary rather than marine character, the so-called Rissòa being a Hydrobia, and the shell described by H. Adams as *Velutina Caspiensis*, a *Limnæa Gebleri*, Midd.

VI. *West African Province.*

The tropical coast of Western Africa is rich in conchological treasures, and far from being wholly explored. St. Helena and Ascension Island are included. About 300 species have been obtained on the coast, and 150 species, mostly identical at the Cape Verd Islands. The most characteristic genera are Pleurotoma, Oliva, Marginella, Cymbium, Terebra, Pusionella, Tympanotomus, Mesalia, Ungulina, Felania, Tugonia, Talona, Tellina. There are 40 species of Marginella, 36 of Pleurotoma, 20 of Tellina. Quite a number of the species cross the Atlantic, recurring upon the opposite Brazilian and West Indian coasts.

VII. *South African Province.*

The fauna of South Africa, beyond the tropic, possesses few characters in common with that of the western coast, and is

more like the Indian Ocean fauna, as might be expected from the direction of the currents. But, together with these it has a large assemblage of marine animals found nowhere else, and the "Cape of Storms" forms a barrier between the populations of the two great oceans, scarcely less complete than the far-projecting promontory of South America. The coast is generally rocky, and there are no coral-reefs; accumulations of sand are frequent, and sometimes very extensive, like the Agulhas Bank. The few deep-sea shells which have been obtained off these banks possess considerable interest, but explorations in boats are said to be difficult, and often impossible on account of the surf. Shells from the Cape are too frequently dead and water-worn specimens picked up on the beach. The shell-fish of South Africa have been collected and described by Quoy and Gaimard, Owen Stanley, Hinds, A. Adams, and especially by Dr. Krauss, who has published a very complete monograph. Of 400 sea-shells recorded in this work, above 200 are peculiar, and most of these belong to a few littoral genera. Only 11 species are common to the coast of Senegal, whilst 18 are found in the Red Sea; 15 species are said to be found in Europe; all the others, not peculiar, exist on the E. coast of Africa. The following are remarkably developed: Chiton, 16 species; Patella, 20 species; Fissurella, 10 species; Trochus, 22 species; Phasianella, 6 species; Cypræa, 22 species.

The following are stated to be common to the Cape and European seas:

Saxicava (arctica?) Greenland, Medit.
Tellina fabula, Brit. Medit.
Lucina lactea, Medit. Red Sea.
" fragilis, Medit.
Venus verrucosa, W. Indies? Brit. Senegal, Canaries, Red Sea, Australia?
Tapes pullastra, North Sea.
" geographica, Medit.
Arca lactea, Medit.
Chama gryphoides, Medit. Red Sea.
Pecten pusio, Brit.

Diphyllidia (lineata?) N. Brit. Medit.
Eulima nitida, Medit.
Nassa marginulata.
Argonauta argo, Medit.

At the islands of St. Paul and Amsterdam, situated midway between the Cape and Australia, Velain collected 60 species, 46 of which he described as new.

VIII. *Indo-Pacific Province.*

This is by far the most extensive area over which similar shell-fish and other marine animals are distributed. It extends from E. Australia to S. Japan, and from the Red Sea and east coast of Africa to Easter Island in the Pacific, embracing three-fifths of the circumference of the globe and 45° of latitude.

This great region might, indeed, be subdivided into a number of smaller provinces, each having a particular association of species and some peculiar shells, such as the Red Sea, the Persian Gulf, Madagascar, etc.; but a considerable number of species are found throughout the province, and their general character is the same. Mr. Cuming obtained more than 100 species of shells from the eastern coast of Africa, identical with those collected by himself at the Philippines, and in the eastern coral islands of the Pacific. This is pre-eminently the region of coral reefs, and of such shell-fish as affect their shelter. The Philippine Islands have afforded the greatest variety, but their apparent superiority is due, in a measure, to the researches of Mr. Cuming; no other portion of the province having been so thoroughly explored. He collected 2500 species of sea shells at the Philippines, and estimates the total number at 1000 more. The genera most developed are Conus, 120 species; Pleurotoma, 100; Mitra, 250; Columbella, 40; Cypræa, 50; Natica, 50; Chiton, 30; Tellina, 50. No catalogue of the marine shells of the Province has been published, but they are believed to amount to between 5000 and 6000 species.

Amongst the genera most characteristic of the Indo-Pacific, those marked (*) are wholly wanting on the coasts of the Atlantic, but half of them occur fossil in the older tertiaries of Europe. Those marked (†) are also found on the west coast of America.

*Nautilus.	*Magilus.	Stomatella.	Hemicardium.
*Pteroceras.	*Melo.	Gena.	*Cypricardia.
*Rimella.	†Mitra.	*Broderipia.	*Cardilia.
*Rostellaria.	*Cylindra.	*Rimula.	†*Verticordia.
*Seraphs.	*Imbricaria.	*Neritopsis.	*Pythina.
†Conus.	Ovulum.	*Scutellina.	Circe.
†Pleurotoma.	†*Pyrula.	*Linteria.	*Clementia.
*Cithara.	*Monoptygma.	*Dolabella.	*Glaucomya.
†*Clavella.	Phorus.	*Hemipecten.	*Meröe.
*Turbinella(typ).	Siliquaria.	*Placuna.	Anatinella.
Cyllene.	*Quoyia.	*Malleus.	Cultellus.
Eburna.	*Tectaria.	*Vulsella.	*Anatina.
†Phos.	†Imperator.	*Pedum.	*Chæna.
Dolium.	Monodonta.	†*Septifer.	*Aspergillum.
†Harpa.	Delphinula.	*Cucullæa.	*Jouannetia.
*Ancillaria.	†Liotia.	*Hippopus.	†*Lingula.
*Ricinula.	*Stomatia.	*Tridacna.	†Discina.

The strictly littoral species vary on each great line of coast: for example, *Littorina intermedia* and *Tectaria pagodus* occur on the east coast of Africa; *Littorina conica* and *melanostoma*, in the Bay of Bengal; *Littorina sinensis* and *castanea*, and

Haliotis venusta, on the coast of China; *Littorina scabra* and *H. squamata*, in N. Australia; *H. asinina*, New Guinea; and *L. picta*, at the Sandwich Islands.

Red Sea (Erythræan). Of the 818 mollusca of the Red Sea, collected by MacAndrew at Suez, three only are common to the Mediterranean Sea.*

The genera wanting in the Mediterranean, but existing in the Red Sea, show most strikingly their diversity of character, and the affinity of the latter to the Indian fauna.

Pterocerаs.	Ancillaria.	Siphonaria.	Limopsis.
Strombus, 8 sp.	Harpa.	Placuna.	Tridacna.
Rostellaria.	Ricinula.	Plicatula.	Crassatella.
Turbinella.	Magillus.	Pedum.	Trigona.
Terebra.	Pyramidella.	Malleus.	Sanguinolaria.
Eburna.	Parmophorus.	Vulsella.	Anatina.
Oliva.	Nerita.	Perna.	Aspergillum.

Other genera become abundant, such as Conus, of which there are 19 species in the Red Sea, Cyprea 16, Mitra 10, Cerithium 17, Pinna 10, Chama 6, Circe 10.

Persian Gulf. The marine zoology of the Persian Gulf and adjoining coast has not been yet explored. 92 species of shells were picked up on the beach at Kurrachee by Major Baker, with many others evidently new, but not in a satisfactory state for description.

Madagascar. Collections of marine shells have been made at Madagascar and the Mascarene Islands by Sganzin, and at the Seychelles by Dufo. The number obtained at the latter place was 263, of which 220 were univalves. Two of the univalves, viz., *Dolium galea* and *Cypræa helvola*, and two of the bivalves, are found in the Mediterranean.

IX. *Australo-Zealandic Province.*

Most remote from the Celtic seas, this province is also most unlike them in its fauna, containing many genera wholly unknown in Europe, either living or fossil, and some which occur fossil in rocks of a remote period. The province includes New Zealand, Tasmania, and extra-tropical Australia, from Sandy Cape, on the east, to the Swan River.

Of the following genera some are peculiar, others attain here their greatest development:—

* Woodward is in error in crediting the statement that 73 out of 375 species collected in the Red Sea, by Ehrenberg and Hemprich are Mediterranean species. Fischer has shown that these 73 species are exclusively Mediterranean forms and were probably collected on the Syrian coast or at Alexandria.

Pinnoctopus.	Macgillivraia.	Cypricardia.	Imperator.
Struthiolaria.	Amphibola.	Mesodesma.	Monoptygm
Phasianella.	Trigonia.	Terebratella.	Siphonaria.
Elenchus.	Chamostrea.	Spirula.	Pandora.
Bankivia.	Myadora.	Oliva.	Anatinella.
Rotella.	Myochama.	Conus.	Clavagella.
Macroschisma.	Crassatella.	Voluta.	Placunomia
Parmophorus.	Cardita.	Terebra.	Waldheimia
Risella.	Circe.	Fasciolaria.	Crania.

Some of the genera of this province are only met with el where at a considerable distance:—

Solenella—Chili.	Solemya—Medit.
Panopæa—Japan.	Rhynchonella—Arctic seas.
Bankivia—Cape.	Trophon—Fuegia; Arctic se
Kraussia—Cape.	Assiminea—India; Brit.

Amongst the littoral shells of South Australia are *Halio elegans*, *H. rubicunda*, and *Littorina rugosa*. *Haliotis iris* a *Littorina squalida* are found on the shores of N. Zealand; a *Cypræovula umbilicata* in Tasmania.

The New Zealand fauna includes about 400 marine species, which about 50 species are common to S. Australia and Tasman

The Auckland Islands contain a number of New Zeala species, together with many Antarctic shells.

X. *Japonic Province.*

The Japanese Islands, the coast of Mantchuria and part Corea represent the Japonic province. Our knowledge of marine fauna has of late years received several valuable acc sions. Of 429 species known in 1875, 145 or about one-third a peculiar to the Japanese Archipelago; 28 are common to t coast of Mantchuria, which presents a more Arctic characte 185 or about three-sevenths are common to China and t Philippines: 165 or about two-fifths, principally from t southern parts, belong to the Indo-Pacific fauna.

A number of species are common to the West Coast America. The following have been cited. They may not all correctly identified, but on the other hand the list could readily made much longer:

Siphonalia Kelletti.	*Lutraria Nuttalli.*
Triton Oregonensis.	*Diplodonta orbella.*
Nassa festiva.	*Tellina nasuta.*
Oliva anazora.	" *secta.*
Solarium quadriceps.	" *inquinata.*
Haliotis gigantea.	*Cardium Californiense.*
Crepidula aculeata.	*Mytilus giganteus.*
Cytherea petechialis.	

The presence of the same genera gives a very similar aspect to the West American and Japonic faunas; especially the development of special forms, such as Saxidomus, Siphonalia, Chlorostoma, etc. A few circumpolar species occur in Japan, several of them being common to the Boreal province on the Atlantic coast of the United States, and to Great Britain. Among them are:

Saxicava arctica.	*Lasæa rubra.*	*Cardita borealis.*
Mya arenaria.	*Crenella faba.*	*Puncturella Noachina.*
Modiola modiolus.	*Nucula tenuis.*	

To complete the story of the intermixture of species, the following Mediterranean forms are also encountered:

Triton olearius.	*Turbo sanguineus* (var.).
Lima squamosa.	*Lithodomus caudigerus.*

XI. *Aleutian Province.*

The species of the Boreal province are well represented on the northern coasts of the Pacific; in addition to which there are many Californian and Japanese forms.

The influence of the Asiatic coast-current is shown in the presence of two species of Haliotis, whilst affinity with the fauna of W. America is strongly indicated by the occurrence of Patella (Scurria), three species of Crepidula, two of Fissurella, and species of Bullia, Placumonia, Cardita, Saxidomus, and Petricola, which are more abundant, and range farther north than their allies in the Atlantic.

The proportion of peculiar species in this Province is already surprisingly small, and is becoming smaller: it has but little claim to rank as a distinct fauna.

Provinces on the Western Coast of America.

The mollusca of the Western coast of America are equally distinct from those of the Atlantic and those inhabiting the central parts of the Pacific, but by no means so peculiar as Woodward supposed. I quote him to show how prepossessions will mislead naturalists:

"Mr. Darwin states in his Journal (p. 391) that 'not one single sea-shell is known to be common to the Islands of the Pacific and to the west coast of America,' and he adds that 'after the comparison by Messrs. Cuming and Hinds of about 2000 shells from the Eastern and Western coasts of America, only one single shell was found in common, namely the *Purpura patula*, which inhabits the West Indies, the coast of Panama, and the Galapagos.' Even this single identification has since been doubted. Mr. Cuming, who resided many years at Valparaiso, did not discover any West India specimens on that coast, and

M. d'Orbigny makes the same observation. On the other hand M. Mörch, of Copenhagen, says he has received *Tellina operculata* and *Mactra alata* from the west coast and also from Brazil; and M. Deshayes gives the following extraordinary ranges in his 'Catalogue of *Veneridæ* in the British Museum':—

Artemis angulosa, Philippines—Chili.
Cytherea umbonella, Red Sea—Brazil.
" maculata, W. Indies—Philippines, Sandwich.
" circinata, W. Indies—West coast America.

In these instances there is doubtless some mistake, either about the locality or the shell. As regards the last, Mr. Carrick Moore has shown that the error has arisen from confounding the *Cytherea alternata* of Broderip with *C. circinata* of Born. M. d'Orbigny collected 628 species on the coast of S. America—180 from the eastern side, and 447 from the Pacific coast, besides the *Siphonaria Lessonii* which ranges from Valparaiso in Chili to Maldonado on the coast of Uruguay. These shells belong to 110 genera, of which 55 are common to both coasts, while 34 are peculiar to the Pacific, and 21 to the Atlantic side of S. America; an extraordinary amount of diversity, attributable partly to the different character of the two coasts—the eastern low, sandy or muddy; the western rocky, with deep water near the shore.

"The comparison of the shells of Eastern and Western America is of considerable interest to geologists; for if it is true that any number of living species are common to the Pacific and Atlantic shores, it becomes probable that some portion of the Isthmus of Darien has been submerged *since* the Eocene Tertiary period. Any opening in this barrier would allow the Equatorial current to pass through into the Pacific—there would be no more Gulf stream—and the climate of Britain might, from this cause alone, become like that of Newfoundland at the present day.

"Although geological researches seem to show that not only the Isthmus of Darien, but even the Rocky Mountains, were sufficiently submerged during the Miocene Epoch to allow of the free intermingling of the waters of the Atlantic and Pacific, yet the special temperate molluscan fauna of E. and W. America are very dissimilar. There are no grounds for believing a single species to be identical. There are, however, a large number of species (upwards of 50) living on both sides of the *northern* portion of the continent, and the majority of these exist in the British seas."

The molluscan fauna of the Panamic and Carribbean Provinces contain very many species in common; these were, for a long period, distinguished as "representative" species, but the con-

tinual occurrence of additional common forms as our knowledge of the two faunas has increased, has finally entirely broken down the dogmatic theory so long held in common by Darwin, Cuming, Hinds, d'Orbigny, Adams, Gould, etc.; finally, the researches of Gabb, in San Domingo and Central America have brought to light in the tertiaries of the Caribbean area a number of species only found living in the Panamic Province. Not only does the Panamic Province hold many species in common with the Carribbean, but some of these are distributed over extensive areas on the West Coast, extending into the Californian and Chilian Provinces.

Woodward's assertion of the distinctness of the Polynesian and West American faunas is also much modified by recent investigations, which show many of the species of Panama to occur at the Galapagos, and quite a number of them to inhabit the Polynesian coasts, even as far as the Philippine Islands and Australia.

XII. *Californian Province.*

This extends from the Straits of Fuca on the north to Cape San Lucas, the southern extremity of the peninsula of Lower California, on the south: it does not include the Gulf of California, which possesses a more tropical fauna, belonging to the Panamic Province. A few circumpolar species extend to Vancouver Island and the coast of Oregon, and of course the Aleutian fauna is well represented in the northern part of the Province; on the other hand the shores of Lower California contain a considerable intermixture of Panamic shells. Still, the Californian mollusca as a whole form a tolerably distinct assemblage of species, widely differing from those of the corresponding East Coast of America, and, although containing many tropical and semitropical forms, sufficiently distinct from the Panamic fauna.

Over five hundred species have been recorded. The most remarkable feature of the Province is the enormous development of the Chitonidæ, Patellidæ, Haliotidæ, Trochidæ, etc.

XIII. *Panamic Province.*

The Western coast of America, from the Gulf of California to Payta in Peru, forms one of the largest and most distinct provinces. The total number of marine shells known belonging to this province was, a few years since, 1341. Amongst these are included 27 Chitonidæ, 13 Acmæidæ, 18 Fissurellidæ, 64 Trochidæ, 28 Calyptræidæ, 69 Pyramidellidæ, 59 Buccinidæ, and 90 Muricidæ. The Gulf of California, together with the adjacent coast as far as Mazatlan and St. Blas, has yielded 768 shells (502 univalves and 266 bivalves), of which 439 also occur

in the Gulf of Panama, while 117 extend into S. America; 635 species are known from the Gulf of Panama; of these, 266 are peculiar to the district, and 163 also occur in S. America. The fauna of the Panamic province in remarkably distinct from the other W. American provinces, and especially the Caribbæan. At one time it was thought that it did not possess a single species identical with any occurring in the West Indies or the east side of America. Dr. P. Carpenter, however, has shown that 35 marine shells (15 univalves and 20 bivalves) occur on both sides of the Isthmus of Darien, and this number has been lately considerably increased.

A few of the species even extend as far as W. Africa, according to Dr. Carpenter; he mentions 15, and among them the following: *Crepidula unguiformis*, *C. aculeata*, *Hipponyx antiquatus*, *Bankivia varians*, *Natica maroccana*, *Marginella cærulescens*, *Nitidella guttata*. Five species are common to Mazatlan and the British coasts, viz., *Kellia suborbicularis*, *Lasea rubra*, *Saxicava arctica*, *Cytherea Dione*, *Hydrobia ulvæ*. Woodward says: "Still more remarkable is the absence of resemblance between the species of Panama and those of the Indo-Pacific area, there being only seven forms common to the two. Thus, *Cytherea petichialis* occurs in Japan; *Nassa acuta*, in Australia; and *Oliva Duclosii*, *Natica maroccana*, *Nitidella cribraria*, *Hipponyx barbatus*, *H. Grayanus*, are scattered over the Pacific ocean." The number of common species in the two Provinces is now known to be very much larger.

The river openings of this coast are bordered by mangroves, amongst which are found Potamides, Arcas, Cyrenas, Potamomyas, Auriculas, and Purpuras, whilst Littorinæ climb the trees and are found upon their leaves. The ordinary tide at Panama amounts to 16 or 20 feet, the extreme to 28 feet, so that once a fortnight a lower zone of beach may be examined and other shells collected. The beach is of fine sand, with reefs of rocks in the bay.

Galapagos Islands. Out of 111 sea-shells collected here by Mr. Cuming, 43 are unknown elsewhere; 25 occur in Mazatlan, 22 in Central America, 38 in Panama, but only 11 in South America.

XIV. *Peruvian Province.*

The coast of Peru and Chili, from Callao to Valparaiso, affords a large and characteristic assemblage of shells, of which only a small part have been catalogued, although the district has been well-explored, especially by d'Orbigny, Cuming and Philippi. M. d'Orbigny collected 160 species, one-half of which are common to Peru and Chili, whilst only one species (*Siphonaria Lessonii*) found at Callao was also met with at Payta, a little beyond the boundary of the region. Mr. Cuming obtained 222 species on

the coast of Peru, and 172 in Chili. Hupé has described 201 species in Gay's work on Chili. The island of Juan Fernandez is included within this province.

The shells of this region are remarkable for melanism. Chiton, Fissurella, Concholepas, Monoceras, Mytilus are predominant, and represented by large and fine species.

D'Orbigny in comparing the Peruvian fauna with those of Brazil, the Argentine Republic and Northern Patagonia mentions the remarkable fact that of 628 marine species, one only (*Siphonaria Lessonii*) lives on both shores of South America. A cold ocean current flows northwards on the West Coast of South America, and has doubtless greatly influenced the distribution of the mollusca.

XV. *Magellanic or Antarctic Province.*

This region includes the coasts of Tierra del Fuego, the Falkland Islands (Maloinas), and the mainland of South America, from P. Melo, on the east coast, to Concepcion, on the west. Fischer has very properly added to this Province Kerguelen's and neighboring islands, intermediate geographically between America and New Zealand, but the mollusks of which are principally American. It is described by M. d'Orbigny and Mr. Darwin (Journal, p. 177 *et seq.*). Philippi also has given attention to it: he assigns 88 species to the district near the Straits of Magellan. Only 15 species are known from the Maloinas, and 11 of these have not been met with elsewhere. The southern and western coasts are amongst the wildest and stormiest in the world; glaciers in many places descend into the sea, and the passage round Cape Horn has often to be made amidst icebergs floating from the south polar continent. The greatest tides in the straits amount to 50 feet. "In Tierra del Fuego the giant sea-weed (*Macrocystis pyrifera*) grows on every rock from low-water mark to 45 fathoms, both on the outer coast and within the channels; it not only reaches up to the surface, but spreads over many fathoms and shelters multitudes of marine animals, including beautiful compound Ascidians, various patelliform shells, Trochi, naked mollusca, cuttle-fish, and attached bivalves. The rocks at low water, also abound with shell-fish which are very different in their character from those of corresponding northern latitudes, and even when the genera are identical the species are of much larger size and more vigorous growth."

Shell-fish are here the chief support of the natives as well as of the wild animals. At Low's harbor a sea-otter was killed in the act of carrying to its hole a large Volute, and in Tierra del Fuego one was seen eating a cuttle-fish.—DARWIN.

A certain number of Arctic genera, which are not found in

warm seas, here reappear, such as Trophon, Buccinum, Margarita, Puncturella, Buccinopsis, Admete, Astarte, Cyanium, etc. Usually, however, these are representative rather than identical genera, the species of Trophon, for instance, constituting a peculiar group, with species extending to New Zealand and Cape of Good Hope, but differing from the typical Trophon of the Arctic mollusca.

Kerguelen's Islands have been recently visited by several scientific expeditions and 58 species of mollusks collected, 13 of which occur on the South American coast, 6 belong to the New Zealand fauna, 4 are found at the Cape of Good Hope. Among them is the genus Struthiolaria belonging to the Australo-Zealandic province: the other genera are South American. *Chiton Belknapi* of the Pacific, *Lasæa rubra* of European seas, and *Terebratulina septentrionalis* of Boreal America also reappear here.

Some peculiar species, together with several stragglers from other regions and faunas have been discovered at the islands of Marion, Crozet and Prince Edward.

Fischer surmises that there exists a circumpolar fauna in the Antarctic as well as in the Arctic regions, and thinks the occurrence of a number of mollusks of the Magellanic province in the south of the New Zealand Archipelago and at the Cape of Good Hope indicates that such is the fact.

XVI. *Patagonian Province.*

From S. Catharina, Brazil, south of the Tropic, to P. Melo, Patagonia. This coast-line has shifted considerably since the era of its present fauna. M. d'Orbigny and Mr. Darwin observed banks of recent shells, especially *Potamomya labiata*, in the valley of La Plata and the Pampas around Bahia Blanca. Mr. Cuming also met with *Voluta Brasiliana*, and other existing shells, in banks 50 miles inland. Of 79 shells obtained by M. d'Orbigny on the coast of N. Patagonia, 51 were peculiar, 1 common to the Falkland Islands, and 27 to Maldonado and Brazil. At Maldonado 37 species were found, 8 being special, 10 common to N. Patagonia, 2 to Rio, and 17 to Brazil. Of the latter 8 range as far as the Antilles; viz.:—

Crepidula aculeata.	Mactra fragilis.	Lucina semi-reticulata.
" protea.	Venus flexuosa.	Plicatula Barbadensis.
Pholas costata.	Modiola viator.	

At Bahia Blanca, in lat. 39° S., the most abundant shells observed by Mr. Darwin (p. 243) were:—

Oliva auricularia.	Oliva tehuelchana.	Voluta angulata.
" puelchana.	Voluta Brasiliana.	Terebra Patagonica.

M. d'Orbigny's list also includes the following genera:—

Octopus.	Lyonsia.	Solen.	Corbula.
Columbella.	Solecurtus.	Lutraria.	Pinna.
Bullia.	Æolis.	Donacilla.	Mytilus.
Pleurotoma.	Paludestrina.	Nucula.	Lithodomus.
Fissurellidæa.	Scalaria.	Leda.	Pecten.
Panopæa.	Natica.	Cytherea.	Ostrea.
Periploma.	Chiton.	Petricola.	

XVII. *Caribbean Province.*

The Gulf of Mexico, the West Indian Islands, and the eastern coast of South America, as far as Rio, form the fourth great tropical region of marine life. The number of shells is estimated by Prof. C. B. Adams at not less than 1500 species, which is certainly an under-estimate. Of these 500 are described by M. d'Orbigny in Ramon de la Sagra's History of Cuba, and a small number of the Brazilian species in the same author's Travels in South America.

The coasts of the Antilles, Bermuda, and Brazil, are fringed with coral reefs, which attain their greatest development around the Bahamas, South of Florida, north of Cuba and at the Bermudas; and there are considerable banks of gulf-weed at some distance from the coast of the Antilles. The peculiar fauna of the coral reefs is therefore represented in the West Indies, but without the richness of zoological forms which characterizes it in the Indo-Pacific province.

The discovery of representatives of ancient genera once supposed to be extinct gives a peculiar interest to this Province. Such are Pholadomya, Pleurotomaria, and Murchisonia. The group Melongena belongs to this fauna and the neighboring Panamic province exclusively, although anciently extending to Europe.

The Caribbæan fauna contains a large number of species common to the West coast of Africa and to Panama; *Dolium galea* of the Mediterranean Sea is also found here. But the most remarkable circumstance is the presence of a number of Indo-Pacific forms, including a dozen species of Triton.

XVIII. *Transatlantic Province.*

The Atlantic coast of the United States was supposed by Prof. E. Forbes to consist of two provinces: (1) The *Virginian*, from C. Cod to C. Hatteras and (2) the *Carolinian*, extending to Florida; but no data were supplied for such a division, and the distribution of the shells does not warrant it. The total number of mollusca is about 300, and 60 of these range farther

north, quite a number being moreover common to Europe. These two regions are sometimes treated of together as the Pennsylvanian province.

I have already stated in treating of the Boreal Province that the barrier of Cape Cod has not influenced the distribution of the mollusca nearly so much as was formerly supposed; that some southern forms surmount it, and that many northern forms extend further southwards. On the other hand, the Gulf Stream has exercised a wonderful influence upon the fauna of the Southern shores of the United States, as far northwards as Fort Macon, N. Carolina, adding many semitropical forms to our mollusca.

Crepidula, Fulgur, large species of Venus and of Mactra are among the characteristic shells of a region which possesses but little claim to the title of a distinct province. Lingula, one of the most ancient of genera, is now nearly confined to the Australian and Philippine seas; yet a peculiar species is found in the waters of North Carolina; and not only a Dolium, but a new Pholadomya, the second living species of that ancient group have been recently dredged by Verrill in New England waters. *Littorina litorea* is a comparatively recent importation from northern Europe. It was first detected, a few years since on the Nova Scotia coast, where it had probably arrived on ballast; we next hear of it as somewhat plentiful around Boston, and it has now spread southwestwards, as far as New Haven, Conn. The writer found it, in the summer of 1881, the most plentiful mollusk on the rocky coasts of Newport, R. I.

BATHYMETRICAL DISTRIBUTION OF MARINE MOLLUSKS.

The distribution of marine animals according to depth is subject to laws quite as evident as those which govern their geographical distribution. Messrs. Audouin and Milne-Edwards (1830), M. Sars (1835), Œrsted (1844), Forbes (1841–2), have studied this subject, and proposed schemes of bathymetrical classification, all founded upon the supposition that the existence of animal life at considerable depths was impossible. Of late years four zones or vertical regions have been recognized; and the deep-sea dredgings of the past fifteen years (having fully demonstrated the existence of life at vast depths, a fifth zone may now be added.

The dredging expeditions which have established the above highly interesting fact, and so largely increased our knowledge of the distribution of the Mollusca are: American, those of the *Corwin* (1867), *Bibb* (1868–1869), *Blake* (1877–1878), *Fish Hawk* (1880–1881); English, *Lightning* (1868), *Porcupine* (1869–1870), *Challenger* (1873–1876), *Valorous* (1875); Scandinavian,

Josephine (1869), *Voringen* (1876); French, *Travailleur* (1880). No greater depth than about 4000 fathoms has been obtained, and the average depth appears to be from 1500 to 1800 fathoms. At the great depth of 2300 fathoms, the naturalists of the *Porcupine* obtained the following mollusks, including their soft parts: *Syndosmya nitida*, *Dacrydium vitreum*, *Pecten fenestratus*, *Neæra obesa*, *Dentalium candidum*.

The water of the ocean gradually becomes cooler from the surface to the bottom. The cooling is rapid between the surface and 250 fathoms, slow but regular between 250 and 850 fathoms, and almost without variation between 850 and 2300 fathoms. The following temperatures were obtained by the *Porcupine* at the mouth of the Gulf of Gascony, July 22, 1869.

Surface, 17° Centigrade; 82 French mètres,* 12° Centigrade; 137 mètres, 11° C.; 402 mètres, 10° C.; 731 mètres, 9° C.; 1005 mètres, 8° C., 1188 mètres, 7° C.; 1280 mètres, 6° C.; 1462 mètres, 5° C.; 1645 mètres, 4° C.; 2560 mètres, 3° C.; 4452 mètres, bottom, 2·5° C.

Three of the five vertical zones of marine life are contained within the depths of surface to 50 fathoms, where the temperature decreases rapidly, and this change of temperature has, of course, marked influence upon all animal life, both directly and by governing the distribution of the plants upon which animals largely feed. Whilst the surface temperature varies greatly in different portions of the globe, the greater the depth the more tendency is there to uniformity, until finally, there is a body of water having the vast thickness of 1000 to 1500 fathoms, at the depth of from 1000 to 2500 fathoms, with scarcely any variation in temperature. It is evident that those mollusks which are able to live in any portion of this belt, may be expected also at its greatest depth, and that in proportion to the depth at which they live, their geographical distribution may increase. Another element which deserves notice is that a shore species in a northern latitude, may spread southwards retaining the temperature suitable to its existence, by seeking greater depths. These general facts are modified in particular localities, and the distribution of the mollusca thereby influenced. Thus the Mediterranean Sea, from a depth of 182 mètres (100 fathoms) to its bottom, 2743 mètres, maintains almost constantly the temperature 55° F., or through a thickness of 2500 metres. There are known to be ocean currents of both warmer and colder water having definite direction and continuous flow, and by means of

* A French mètre = 39+ inches, therefore 2 mètres rather more than equal a fathom (6 feet). To reduce the Centigade readings to those of Fahrenheit's thermometer, $C^{\circ}\frac{9}{5}+32 = F^{\circ}$.

these currents mollusks may spread into localities distant from their specific metropolis.

The five bathymetrical zones are:

1. Littoral. Between tide-marks.
2. Laminarian. From low water to 15 fathoms.
3. Coralline. From 15 to 50 fathoms.
4. Deep-Sea. From 50 to about 300 fathoms.
5. Abyssal. From 300 to 3000 fathoms, or more.

1. *The Littoral Zone* depends for its depth on the rise and fall of the tide, and for its extent on the form of the shore. The shells of this zone are more limited in their range than those which are protected from the vicissitudes of climate by living at some depth in the sea. The characteristic genera of rocky shores are Littorina, Patella, and Purpura; of sandy beaches, Cardium, Tellina, Solen, Mactra, Natica, Donax, Petricola, etc.; gravelly shores, Mytilus; and on muddy shores, Lutraria and Pullastra. On rocky coasts are also found many species of Haliotis, Siphonaria, Fissurella, and Trochus; they occur at various levels, some only at the high-water line, others in a middle zone, or at the verge of low water. Cypraea and Conus shelter under coral-rocks, and Cerithium, Terebra, Natica, and Pyramidella burrow in sand at low water, but may be found by tracing the marks of their long burrows. The sea-shore collector will obtain principally littoral shells; with occasionally others washed ashore from greater depths; usually dead and empty.

2. *Laminarian Zone.* In this region, when rocky, the tangle (Laminaria) and other sea-weeds form miniature forests, the resort of the vegetable-feeding mollusks — Lacuna, Rissoa, Nacella, Trochus, Aplysia, and various Nudibranchiata. On soft sea-beds bivalves abound and form the prey of Buccinum, Nassa, and Natica. From low-water to the depth of one or two fathoms on muddy and sandy shores, there are often great meadows of grass-wrack (Zostera) which afford shelter to numerous shell-fish, and are the haunt of the cuttle-fish and calamary. In tropical seas, the reef-building corals often take the place of sea-weeds and extend their operations to a depth of about 25 fathoms. They cover the bottom with living verdure, on which many of the carnivorous mollusks feed, while some, like Ovulum and Pedicularia, browse on the flexible Gorgoniæ. To this zone belong the oyster-beds of our seas, and the pearl-fisheries of the [illegible]. It is richer than any other in animal life, and affords the most [illegible] shells.

3. *Coralline Zone.* In northern seas the belt of sea-weed that fringes the coast is succeeded by a zone where horny zoophytes are abundant, the chief vegetable growth consists of Nullipore, which covers rocks and shells with its stony-looking incrusta-

tions. This zone is inhabited by many of the predacious genera —Buccinum, Fusus, Pleurotoma, Natica, Aporrhais, Philine, Velutina; and by vegetable feeders, such as Fissurella, Emarginula, Pileopsis, Eulima, and Chemnitzia. The great banks of scallops belong to the shallower part of this region, and many bivalves of the genera Lima, Arca, Nucula, Astarte, Venus, Artemis, and Corbula.

4. *Deep-sea Zone.* From 50 to 100 fathoms the Nullipore still abounds, and small branching corals to which the Terebratulæ adhere. In northern seas the largest corals (Oculina and Primnoa) are found in this zone, and shells are relatively more abundant, owing to the uniformity of temperature at these depths. These deep-water shells are mostly small and destitute of bright colors; but interesting from the circumstances under which they are found, their wide range, and high antiquity. Amongst the characteristic genera are Crania, Thetis, Neæra, Cryptodon, Yoldia, Dentalium, and Scissurella. In the mud brought up from deep water may be often found the shells of Pteropoda, and other mollusca which live at the surface of the sea.

5. *Abyssal Zone.* The fauna of this zone and its distribution are as yet hardly known. Mollusks continue abundant at from 300 to 1200 fathoms, but the number of species appears to be small. At the depth of 2435 fathoms, the Porcupine Expedition obtained five species, and at 2740 fathoms the Challenger Expedition dredged three pelecypods, Arca, Limopsis, and Leda.

Usually the mollusks of this zone are of small size, not highly colored, with a white, thin and translucent shell. The visual organs are rarely deprived of pigment; *Eulima stenostoma*, *Pleurotoma nivalis*, and *Pecten fragilis* are stated to be blind.

The dominant forms of great depths are the Scaphopoda (Dentalium, Siphodentalium, Cadulus), the tetrabranchiate Gastropoda (Philine, Cylichna, Utriculus, Scaphander, Actæon, some species of Pleurotoma and Fusus), a few of the rhipidoglossata (Scissurella, Punctureila, Cyclostrema, Seguenzia), and some lamellibranchs (Arca, Limopsis, Nucula, Leda, Malletia, Lima, Pecten, Amussium, Dacrydium, Axinus, Pecchiolia, Syndosmya). Brachiopods are also found; one species, *Terebratula Wyvillei*, at a depth of 3000 fathoms.

Wyville Thomson has compared these abyssal shells with the cretaceous fauna, but they are not at all related, resembling rather the pliocene fauna of Italy, and the recent fauna of less depth in the Arctic and Antarctic seas—where analogous temperature prevails, and whence the species may have immigrated.

In 1863, S. Lovén emitted the opinion that a fauna of identical character extends from pole to pole, traversing all the degrees

of latitude. Thomson has arrived at the same conclusion; which appears probable from the number of identical abyssal species already obtained from far distant localities.

That mollusks are able to subsist through a great range of depth may be shown by the five species obtained by the *Porcupine* at 4451 mètres:—

Dentalium candidum, 749–2010–3200 m.
Dacrydium vitreum, 54–5027 m.
Syndosmya nitida, 7–200 m.
Neæra obesa, 36–73 m.
Pecten fenestratus, 91–457 m.

Terebratula Wyvillei lives between 1891 and 5300 mètres.

Mr. W. H. Dall, from the study of the extensive dredgings made by the "Blake" in the Gulf of Mexico (Bull. Mus. Comp. Zool., vi, 1880), has been able to fully illustrate the range of bathymetrical distribution: the material studied embracing nearly 500 species belonging to not quite 100 genera, and obtained from depths varying from a few fathoms to 1920 fathoms. Many species range from 30 to over 800 fathoms; a fact of extensive distribution which had never been so clearly indicated before, as most of the deep-sea expeditions omitted carrying their investigations continuously from the abyssal into the littoral regions. Mr. Dall finds that, whilst many species have a limited vertical range, a fair proportion extend from littoral to abyssal; of these about ten per cent. (in the Gulf of Mexico) belong to boreal or cold-water forms.

LAND REGIONS.

Distribution of Land and Fresh-water Shells.

The boundaries of the Natural-History land-regions are more distinctly marked, and have been more fully investigated, than their counterparts in the sea. Almost every large island has its own fauna and flora; almost every river system its peculiar fresh-water fish and shells; and mountain-chains like the Andes appear to present impassable barriers to the "nations" of animals and plants of either side. Exceptions, however, occur which show that beyond this first generalization there exists a higher law. The British Channel is not a barrier between two provinces, nor is the Mediterranean; and the Desert of Sahara separates only two portions of the same zoological region. In these and other similar instances the "barrier" is of later date than the surrounding fauna and flora.

The specialization of island faunas is one of the most astonishing facts connected with this subject. Almost every large island, when surrounded by deep water, has its peculiar types of

genera of terrestrial mollusca; Cuba, Jamaica, Hayti, Madagascar, New Caledonia, Australia, the Philippines, etc., may be cited. Even small islands, such as Malta, Lampedusa, Cos, Naxos, Corfu, Zante, Lesbos, Eubœa, Rhodes, in the Mediterranean Sea, are characterized by the presence of species not found elsewhere. The exceptions are, as in the case of England, where the present species, identical with those of the adjacent continent, antedate the formation of the British Channel.

It has been often remarked that the northern part of the map of the world presents the appearance of vastly-extended, continental plains, much of which is, geologically speaking, new land. In the southern hemisphere the continents taper off into promontories and peninsulas, or have long since broken up into islands. Connected with this is the remarkable fact that only around the shores of the Arctic Sea are the same animals and plants found through every meridian; and that in passing southward, along the three principal lines of land, specific identities give way to mere identity of genera; these are replaced by family resemblances, and at last even the families of animals and plants become in great measure distinct, not only on the great continents, but on the islands, till every little rock in the ocean has its peculiar inhabitants—the survivors, seemingly, of tribes which the sea has swallowed up (Waterhouse).

The two largest genera, or principal types of the land and fresh-water shells, Helix and Unio, have an almost universal range, but admit of many geographical subdivisions. Amongst the land snails are several species to which a nearly world-wide range has been assigned, sometimes erroneously, and often correctly, but usually only because they have been carried to distant localities by human agency. Land snails are in favor with Portuguese sailors, as "live sea stock;" and they have naturalized the common garden-snail of Europe (*Helix aspersa*) in Algeria, the Azores, and Brazil;* and *Helix lactea* at Teneriffe and Montevideo. *Achatina fulica* has been taken from Africa to the Mauritius, and thence to Calcutta, where it has been established by a living naturalist; and *Helix hortensis* has been carried from the old country to America, and naturalized on the coast of New England and the banks of the St. Lawrence, and elsewhere. *Bulimus Goodalli*, indigenous to the West Indies and South America, has been introduced into English pineries and to Mauritius. *Helix pulchella*, one of the small species found in moss and decayed leaves, inhabits Europe, the Caucasus, Madeira,

* French emigrants introduced this species twenty-three years ago at San Jose, California, where it still exists, within a limited area, and is gathered for food.

the Cape (introduced), and nearly all the northern portion of North America. *Helix cellaria* inhabits Europe and the Northern United States, and has been carried abroad with the roots of plants, or attached to water-casks, and naturalized at the Cape and New Zealand. *Testacella maugei* has been transported from the Canary Islands to England. *Helix similaris*, a native of Eastern Asia, lives in South Africa, Australia, Polynesia, Brazil, the West Indies, etc., wherever the coffee-tree is cultivated. *Ennea bicolor* has a very similar distribution, by human agency. The Canary Islands, Azores and Madeira support a considerable number of European Helices, introduced with cultivated plants: even St. Helena has a half-dozen acclimated European species.

Several species of fresh-water pulmonates, Limnaea, Physa, Planorbis, are common to both continents: some of them well distributed over either, others apparently originating in one and introduced into the other. American species thus occur in England in isolated localities, and others known to be of European origin have from time to time been made known as inhabiting the United States.

The best known and most instructive instance of the spread of a bivalve mollusk is that of *Dreissena polymorpha*. Pallas discovered it in 1769 at the mouth of the River Volga, which empties into the Caspian Sea. It was subsequently found in the rivers flowing into the Black Sea, the Dneiper, Danube, etc. From the latter it is supposed to have been carried into Germany by the pontoon trains during the wars of Napoleon, and became known as a German mollusk in 1814; as English, toward 1824. In London they have caused trouble by growing in the water-pipes, and in 1834 they appeared in Edinburgh. They were discovered in Belgium in 1833, and their march into various parts of France has been heralded by various local collectors at periods extending from 1838 to 1866: so that in twenty-five years this mollusk spread throughout all the great hydrographic basins of France. If, says Fischer, this extension had occurred several centuries ago, it would have been impossible to ascertain the original locality of the species, except by reference to its fossil remains: these show that it did not exist in the quarternaries of Western Europe, but that it occurred in the chalk of the Steppes.

The Old World and America may be regarded as provinces of paramount importance, having no indigenous species in common (except a few in the extreme north), and each possessing many characteristic genera.

AMERICA.	OLD WORLD.	AMERICA.	OLD WORLD.
Strebelia.	Daudebardia.	Tomocyclus.	Leptopoma.
Streptostyla.	Testacella.	Choanopoma.	Pupina.
Selenites.	Ennea.	Cistula.	Callia.
Guestieria.	Gonospira.	Geomelania.	Alycæus.
Stenopus.	Gibbus.	Trochatella.	Acme.
Sagda.	Parmacella.	Alcadia.	Pirena.
Binneya.	Hyalimax.	Lucidella.	Vibex.
Pallifera.	Geomalacus.	Bourcieria.	Melanopsis.
Anostoma.	Nanina.	Stoastoma.	Canidia.
Bulimus.	Parmarion.	Proserpina.	Paludomus.
Odontostomus.	Helicarion.	Ceres.	Lithoglyphus.
Liguus.	Boysia.	Chilina.	Lacunopsis.
Orthalicus.	Hypselostoma.	Pompholyx.	Benedictia.
Cylindrella.	Achatina.	Pachychilus.	Baïkalia.
Macroceramus.	Pseudachatina.	Pleurocera.	Lanistes.
Megaspira.	Limicolaria.	Goniobasis.	Navicella.
Strophia.	Columna.	Anculotus.	Ætheria.
Berendtia.	Bulinus.	Io.	Iridina.
Eucalodium.	Cataulus.	Tulotoma.	Spatha.
Rhodea.	Pterocyclos.	Melantho.	Galathea.
Simpulopsis.	Pomatias.	Lioplax.	Velorita.
Gæotis.	Otopoma.	Mulleria.	Batissa.
Peltella.	Craspedopoma.	Castalia.	Fischeria.
Amphibulima.	Diplommatina.	Monocondylus.	Cyrenella.
Homalonyx.	Aulopoma.	Rangia.	Glauconomya.

Oceanica contains comparatively few peculiar generic types. The following may be cited:

Athoracophorus.	Carelia.	Paryphanta.
Rhytida.	Achatinella.	Ameria.
Diplomphalus.	Auriculella.	Latia.
Placostylus.	Endodonta.	Ampullacera.
Partula.		

The malacological fauna of Oceanica is not intermediate in character between those of the Old and New Worlds; it has a distinct series of forms, nearest allied, however, to those of Asia, to which it approaches through the Malaysian Islands.

Woodward has adopted for the land regions the principal Botanical Regions, 27 in number, of Prof. Schouw, as given in Berghaus' Physical Atlas: they are mostly natural regions for the terrestrial mollusks, but several of them are not in accordance with the actual grouping of the species. Fischer has attempted in several instances to improve upon Woodward's divisions; successfully on the whole, although some of his regions, do not, we think, possess distinctive characters.

The regions of Fischer will be herein shortly described, and their correlation with those of Woodward is exhibited in the annexed table.

Zone.	Fischer. *Regions.*	Woodward.
Palæarctic.	1. Septentrional.	Germanic.
	2. Mediterranean.	Lusitanian (part).
	3. Central Asiatic.	(Wanting.)
	4. Chinese.	China and Japan.
	5. Japanese.	China and Japan.
	6. Atlantic.	Lusitanian (part).
Palæotropical African.	7. Central African.	African.
	8. Western African.	African.
	9. Southern African.	Cape.
	10. Malgachian.	Yemen, Madagascar.
	11. Afro-Arabic.	Yemen, Madagascar.
Palæotropical Oriental.	12. Indian.	Indian.
	13. Indo-Chinese.	Indian.
	14. Indo-Malaysian.	Java, Borneo.
	15. Philippine.	Philippines.
Australian.	16. Austro-Malaysian.	New Guinea (part).
	17. Australian.	Australian, North Austral. & Tasmanian.
	18. Austro-Polynesian.	Polynesian.
	19. Polynesian.	Polynesian.
	20. Neozelandic.	N. Guinea (pt.) N. Zeal.
Neantarctic.	21. Patagonian.	Argentine, Patagonian
	22. Chilian.	Chilian.
Neotropical.	23. Peruvian.	Peruvian.
	24. Columbian.	Columbian.
	25. Brazilian.	Brazilian.
	26. Mexican.	Mexican.
	27. Caribbæan.	Antilles.
Nearctic.	28. American.	American.
	29. Californian.	Oregon & California.
	30. Canadian.	Canadian.

1. Septentrional Region.

This includes the whole of the northern portion of the old world; it may be divided into two subregions:—

1. *European Subregion.* Its southern limits are the Pyrenees, the Alps, the Carpathians, the Caucasus. The forms are not numerous; something over 200 species of land shells, the greater part of which are found likewise inhabiting the Mediterranean region. They are usually small, and not conspicuous in coloring.

They are very numerous in individuals, and unlike the species of the United States, which occur mostly in moist, shaded woodlands, they are frequently found in exposed, sunny situations. The species are most numerous towards the southern boundary of the region, and in cold countries are few.

About twenty species of land and fresh-water mollusca are found in Iceland and the Faroë Islands. 127 species occur in Great Britain; two only of which *Limnæa involuta* and *Assiminea Grayana*, are peculiar to it. On the other hand several species are introduced (not indigenous). A few European species not now living in Great Britain, are found there as quaternary fossils; whilst some of the commonest living species are not found in the quarternary, hence must have become British within comparatively recent times.

The malacology of the northern, central and eastern portions of France presents no particular features; but in the neighborhood of the Vosges, Jura and Alpine ranges occur a few Helices, etc., belonging to mountainous regions. The southern and western parts of France include a large infusion of the species proper to the Mediterranean Province. The French quaternaries tell the same tale of the extinction of some species and subsequent introduction of others, as do those of Great Britain; among the former is a special group of small Hydrobias, called Lartetia.

The countries of the north of Europe contain approximately: Sweden, 136 species; Norway, 80; Lapland, 16; Finland, 75; Denmark, 133.

Helix harpa, Say, a minute American shell, is probably circumpolar in distribution as it has been found in Labrador, British America, Norway, Sweden and Lapland.

Germany possesses 248 species, of which 125 occur throughout Europe. The vast plains of Northern Russia have a fauna resembling that of Germany.

Siberian Subregion. In 1877, Westerlund enumerated 137 species, of which 48 are terrestrial and 89 fluviatile. A number of these are European species, several of them circumboreal; such as *Vitrina pellucida*, *Helix pulchella*, *Cionella lubrica*, *Pupa muscorum*, *Physa hypnorum*, *Linnæa auricularia*, *L. palustris*, *L. stagnalis*, *Planorbis albus*, *Margaritana margaritifera*, all of which recur in British North America and the northern parts of the United States.

There are a dozen or twenty special forms in Siberia, but they are mostly of European aspect, and in some cases are not really distinct from European species. In Lake Baikal, however, is a special fauna, one of the most distinctive in existence; it is characterized by a number of genera related to Hydrobia (represented in the Colorado Desert of N. America by the peculiar genus Tryonia), Choanomphalus (related to the Californian

genus Carinifex), Valvata, Ancylus, etc. Kamtschatka has six terrestrial and seven fluviatile species, three of the former, so far, peculiar.

The Amour territory, the North of China, Thibet and Turkestan, although excluded from this region, contain a large percentage of European forms.

2. Mediterranean Region.

All the countries bordering on the Mediterranean, the Black and the Caspian Seas form a vast terrestrial region inhabited by a very varied fauna. This region is limited by the African desert, the Atlantic, the Alps, and to the east, by the Central Asiatic region—with the species of which it intermingles in such manner that certain authors consider the latter as a mere subdivision. The immense development of the genus Clausilia is characteristic of this region; and in a less marked degree, the number of species of Buliminus, Testacella, Daudebardia, Calcarina, Pomatias. Certain sections of the Helices also are hereunto restricted. Among the species distributed throughout the entire province may be cited *Bul.* (*Rumina*) *decollata*, *Helix* (*Calcarina*) *candidissima*, *aperta*, *vermiculata*, *Pisana*, *variabilis*, *pyramidata*, *acuta*, *Buliminus pupa*, *Ferussacia folliculus*, *Physa* (*Isidora*) *contorta*, *Melanopsis prærosa*, *Unio littoralis*, etc.

Fischer thus subdivides the region:

a. Occidental or Atlantic Subregion.

b. Meridional or Mediterranean Subregion: including the
- Hispano-Barbaric Fauna.
- Egypto-Syrian Fauna.
- Hellado-Anatolic Fauna.
- Italo-Dalmatian Fauna.

c. Central or Pontic Subregion.

d. Oriental or Caspian Subregion.

The first of these includes Portugal, North Spain and the West of France; it contains a number of characteristic forms, a few of which extend beyond its boundaries. Some of these species, however, are scarcely entitled to be considered more than varieties of mollusks having a more general distribution.

In the Mediterranean subregion there are, as Fischer has pointed out, several faunal provinces distinguished by characteristic groups of related forms, evidently derived from a common ancestry: such are the species of Helix belonging to the sections Macularia and Calcarina, those of Melanopsis, etc. The genus Clausilia is very rare in Spain, and wanting in its southern portion. In the Balearic Islands three-fourths of the species are Spanish, the rest mostly peculiar—including several Helices of the section Jacosta, only found there.

The shells of Northern Africa are more closely related to those of Spain than to those of Sicily, yet the ancient connection

of that island with the African continent is manifested by some species common to both countries, but wanting in Spain. In Algiers considerably over 300 species have been enumerated, including a number of Helices of the sections Macularia and Helicella, numerous species of Ferussacia, etc. A considerable number of species are peculiar. The Desert of Sahara contains very few forms.

Egypto-Syrian Fauna. The fresh-water shells of the Nile have a decidedly African character, Ampullaria and Lanistes being found in Lower Egypt, Limicolaria, Physopsis, Ætheria and Spatha in Upper Egypt. The terrestrial shells of Egypt, on the contrary, are evidently of Syrian type and derivation: the group Macularia, for instance, so characteristic of the Barbary States, being reduced to a single species, whilst Syrian groups include most of the Helices. Besides these, Syria itself contains a number of species of Buliminus, of Clausilia, section Cristataria, Ferussacia, Melanopsis, Unio, etc., which are peculiar to this country. No shells live in the Dead Sea.

Hellado-Anatolian Fauna. The shells of Asia Minor include many of those of Syria, with Northern colonies from the Pontic region and western ones from the Archipelago and Greece. The Asiatic coast of the Black Sea properly belongs to the Pontic fauna. The most interesting facts in connection with the distribution of mollusks in this region are the presence of the large typical Zonites, represented by four species, of numerous species of Buliminus, and of Clausiliæ belonging to the sections Medora and Melinda.

In Greece and its islands, the fauna has relationships with that of Dalmatia, Asia Minor and the Pontic region. The Anchistoma and Campylæa sections of Helix, Buliminus and Clausilia are well represented. The latter genus is enormously developed, including 25 out of the 75 species of land mollusks known to inhabit the island of Crete; with peculiar forms in many of the islands.

Dalmatia, Carniola, Carinthia and Croatia have a molluscan fauna related on the whole most nearly to that of Italy, although the three latter belong geographically to the Black Sea basin. Here again the development of Clausilia is remarkable, numbering 80 out of 254 Dalmatian terrestrial species, and including some of the largest forms of that genus in Europe. The Helices are represented especially by several large species of Campylæa and four species of Zonites. There are also several Pomatias. A special fauna of blind mollusks inhabits the caverns of Carniola, most of them being very much restricted in their distribution: they are very small species, and include a Helix, no less than nine species of Zospeum (Pupa), a Bythinella and two Valvatæ.

Italy and its islands contained in 1878, according to M. Paulucci, 534 species of land and fresh-water shells, a remarkable development of molluscan life. Of these, 230 species are inhabitants of Sicily, including a number of forms special to that island. The Helices are rich in the section Campylæa, 16 species, in Iberus, etc.; there are 80 species of Clausilia, and 22 of Pomatias.

The Pontic and Caspian subregions partake in general character with the Italo-Dalmatian fauna, with, nevertheless, a number of special forms in each. The basin of the Danube is characterized by the development of certain types of fresh-water univalve mollusks, Lithoglyphus, *Melania Hollandri* and *parvula*, Melanopsis. Transylvania possesses a particular form of Clausilia (Baleoclausilia), of which 5 species are known. In the Crimea are found 9 species of Buliminus, certain localized Clausiliæ, etc. The Turkish territory bordering on the Black Sea has 7 species of the group Pomatia (Helix). Transcaucasia has 160 species of land and fluviatile shells, 67 of which are supposed to be peculiar to the region.

The great richness of molluscan life in the Mediterranean Region, the abundance of individuals, and the thoroughness with which its localities have been explored, have combined to give it an importance beyond that of any other land region, both in conchological literature, and usually also in the cabinets of collectors. The Helicidæ alone will number considerably over a thousand nominal species—some of which, however, are merely races or geographical varieties. Clausilia, with its three hundred species, only finds a parallel in importance among cylindrical, many-whorled forms in the West Indian genus Cylindrella.

3. Central Asiatic Region.

The shells of Turkestan, Afghanistan and Thibet, are not well known. These countries have only been partially explored, and the hundred species which have been collected in their extensive territories, scarcely form a sufficient basis for a scientific estimate of the character of the fauna. Many of the species, of fresh-water univalves especially, are those common to Europe (and in some instances to North America); although there are some peculiar forms reported from each of the countries comprising the region. There are no species of Pomatias and but two or three of Clausilia, only one Unio; but Helices are numerous, belonging mostly to North European groups. It may well be doubted whether this should rank as a distinct region, for it partakes, as far as known, too largely of the characteristics of the Septentrional and Mediterranean Regions.

4. Chinese Region.

The conchological fauna of the North of China is palæarctic in character, whilst that of the central and southern provinces and of the islands is palæotropical. There are a number of special groups of Helices, such as Plectotropis, Acusta, Camena, Ægista, Corilla, etc.; as well as a few Clausilia, Stenogyra and Buliminus. The more southern regions include some tropical forms (of which a large proportion, as in tropical America, are operculated). Among these may be named Streptaxis, Pupina, Cyclotus, Diplommatina, Cyclophorus, Alycæus, Realia, Paxillus, Helicina. The rivers are filled with magnificent species of Paludina and Melania, but fresh-water pulmonates are very few. Bivalve mollusks of the Corbiculadæ and Unionidæ are very numerous; the species of the former numbering over 50, exceeding in variety any other region; whilst the Unionidæ (including the special group Dipsas), are developed beyond any region except that of North America—more than 100 species being already known, although most of the streams have not been thoroughly explored.

5. Japanese Region.

Nearly 200 species of land and fluviatile mollusks are known; of which 73 belong to Helix and Hyalinia, 36 to Clausilia (several gigantic forms—for the genus), 23 are operculated, etc. The Helicidæ and operculates are of Chinese groups mostly; there are 8 species of Paludina, and 5 of Melania; but the Unionidæ, so plentiful in China, are here scarce, numbering but a dozen species; there are 9 species of Corbiculadæ.

Several of the species of North Japan are of extensive distribution:

Helix (*Hyalinia*) *nitida*—Europe. *H.* (*Hyalinia*) *minuscula*, N. Am.

Limnæa auricularia and *ovata*, and *Planorbis albus*, Europe; *Bythinea striatula*, Amour; *Anodonta herculea* and *Margaritana Dahurica*, Siberia.

6. Atlantic Region.

The Azores, Canaries, Madeira and Cape Verd Islands contain conchological faunas astonishing in their individuality. The theory that these islands are the last vestiges of a vast Atlantic continent is scarcely in accord with the distribution of their shells, for not only are the species usually restricted to each group, but even some of the generic groups are similarly localized; nor have these any relationship to the forms of the African, European or American faunas. European species are numerous, it is true, but they appear to have been accidentally

introduced and acclimated since the occupation of these islands by the Spaniards and Portuguese, as they are confined to the cultivated portions of the islands and do not occur in the latest fossil deposits. The genus Craspedopoma is characteristic of this fauna. No species of Unio occur, and in the Azores, not a single species of fluviatile mollusca. In Madeira the characteristic groups of Helices are Leptaxis, Janulus, Actinella, Ochtephila, Phlebecula, Tectula; in the Canaries, Hemicyclus, Moniliaria, etc. The ancient sandy dunes of Caniçal, at the eastern extremity of Madeira and in Porto Santo, contain numerous terrestrial mollusks, some of which have not been found in a living state. As the fossil examples of several species are larger than their living descendants, it is possible that some of these species reputed to be extinct have only degenerated. It is a remarkable fact that some of the commonest living species are not found fossil, whilst others, now extremely scarce, occur abundantly as fossils. *Helix tiarella* was supposed to be extinct until 1855, when Mr. Wollaston detected it alive in two almost inaccessible spots on the north coast of Madeira. The degeneration of the land shells in variety and size may be the result of a modern change of physical conditions brought about by human agency. The annual fall of rain is now 29.82 inches, whereas it was remarked by Columbus, nearly 400 years ago, "that, formerly, the quantity of rain was as great in Madeira, the Canaries, and the Azores, as in Jamaica, but since the trees which shaded the ground had been cut down, rain had become much more rare."

In the Azores there are 71 species, in Madeira 164, in the Canaries 189. Cape Verd 40; some of these are common to two or more groups, and some of the 50 introduced species in each case form part of the enumeration.

7. Central African Region.

This region, limited to the North, by the Desert of Sahara, includes the whole of intertropical Africa, with the exception of the basin of the Gulf of Guinea. Some of its species are distributed northward, following the course of the Nile, as far as Lower Egypt. The characteristic genera are Limicolaria, Achatina, Ennea, Lanistes, Ætheria, Iridina and Spatha. There are scarcely any Helices and the operculated land shells are very few. The three first genera enumerated are bulimoid land shells, Achatina including a number of very large species, only comparable in size with the Bulimi of the Borus group inhabiting Brazil, etc. There are a few fresh-water pulmonates, the Physæ being represented by the groups Physopsis and Isidora; but most of the fluviatile univalves are gill-breathers, including Melania, Paludina, Ampullaria, and the peculiarly African group Lanistes (reversed Ampullariæ). There are some Unios,

but the bivalves are principally Spatha, Iridina, and the fresh-water oyster, Ætheria. The Corbiculadæ are represented by the genus Cyrenella and two species of Corbicula. There are two African species of Dreissensia; both smaller than the *D. polymorpha*, which has spread with such amazing rapidity throughout Europe.

In Lake Tanganyika occur two special genera, viz.: Tiphobia, somewhat resembling the American genus Io, and perhaps a Melanian, and Neothauma, a group of the Paludinidæ; besides some mollusks simulating marine genera, such as Trochus, Littorina, etc. A number of species of Melania have been described from Lake Nyassa, but I think that they are mostly extreme forms of *M. tuberculata*, Müller. This lake contains several Lanistes, Paludina, Physa, etc., with a Unio and two Spathas.

The few African Cyclostomæ mostly occur upon the East Coast, Mozambique, Zanzibar, etc.

8. West African Region.

The malacological fauna of intertropical West Africa appears to be very rich, although the country is far from being thoroughly explored. With such characteristic genera as Columna, Perideris, Pseudachatina, Streptostele, Galatea, Fischeria, there are associated others which indicate relationship with Central Africa; these are Achatina, with equally large species, Ennea, and particularly the fluviatile genera Ampullaria, Lanistes, Isidora, Physopsis, Iridina, Spatha. Only two operculated land snails are known. The river mouths abound with brackish-water shells Tympanotomus, Capsella.

In Guinea, Morelet enumerated in 1868, 141 species, of which were Helix 6 (mostly of the group Nanina), Streptaxis 5, Limicolaria 7, Achatina 7, Perideris 10, Stenogyra 3, Ennea 5, Melania 5, Pirena 3, Neritina 4, Unionidæ 5, etc.

In the Gabon region about 50 species are catalogued also by Morelet. The characteristic genus is Pseudachatina, including 5 species. Some of the largest Achatinæ are found in this district, but the metropolis of this genus is in Angola and Benguela, from which 16 species have been sent. Here the fresh-water pulmonates are unexpectedly largely developed; there are 3 Planorbis, 4 Limnæa, 10 Physa.

The little, mountainous Prince's Island affords 25 species; its specialties being the genera Columna, 3 species, and Streptostele, 4 species.

The Island of St. Helena is 1200 miles from the nearest African coast of Benguela. It is entirely volcanic. The indigenous plants are all peculiar, and not more related to those of Western Africa than to Brazil. The land shells are all peculiar, except a

few acclimated European species, and are of 10 species only: but as many additional species are found as dead shells only, rarely retaining their color and translucency. They are found beneath the surface soil in the sides of ravines worn by the heavy rains, at a height of 1200 to 1700 feet. "Their extinction has probably been caused by the entire destruction of the woods, and the consequent loss of food and shelter, which occurred during the early part of the last century" (Darwin's Journal, 488). Of the dead shells thus found, the only species which still survives is *Succinea Bensoniana*. Among the extinct species are 7 Bulimus, including the curious *B. aurisvulpina*, and belonging to two groups, both special to the island. The Helices appertain to Endodonta, a Polynesian group. Three species of Succinea form the special group Helisiga, and live in high parts, on the leaves of arborescent compositæ. Thus the ensemble of characters of the molluscous fauna is original, and shows that St. Helena has been insulated since a very early period.

Ascension Island, 800 miles N. W. of St. Helena, is not known to possess any molluscous inhabitants, except a slug, *Limax Ascensionis*.

9. South African or Cape Region.

About 100 species have been collected in this region. The genus Helix is very abundant, contrasting with the scarcity of heliciform shells in intertropical Africa. The Helices belong to two types, Dorcasia 5 sp.; Pella 10 sp.; and there is also the large diaphanous *Helix Caffra*, the mollusk of which is carnivorous, and is made the type of the genus Ærope. There are 11 sp. of Achatina and 12 of Ennea, and a few Cyclostomidæ, 4 Unionidæ. The genera Physopsis, Isidora and Spatha are also represented, as throughout Africa.

10. Malgachian Region.

This includes, besides Madagascar, the islands of Bourbon, Mauritius, Rodriguez, the Comoros and Seychelles. Whilst the specific forms are peculiar to each island, the genera are common to all and thus unite them into a single malacological province. We find here a large development of carnivorous species having pupiform shells, Ennea, Gibbus; and the Cyclostomidæ are predominant, attaining their greatest representation in Madagascar, where many of them are spirally ridged (Tropidophora). There is only one Helicina, at the Seychelles.

In Madagascar there are more than 150 species of terrestrial and fluviatile mollusks. The Helices, 15 in number, are beautiful, and mostly belong to the genera Helicophanta and Ampellita; one of them *H. viridis* is a Cochlostyla—a Philippine Island group. There are 47 species of Cyclostoma, 13 Neritina,

7 Melania, 4 Pirena, a few Limnæa, Physa, Planorbis, Ampullaria, Paludomus, Paludina, Lanistes, etc. A very doubtful Unio and a Cyclas are the only bivalves found in this region. As might be expected, Madagascar, besides the special forms of the region, possesses some purely African genera; but these may have been introduced. The dunes of Cape St. Marie, where occur the bones of the gigantic extinct bird, Æpyornis, contain a few equally extinct shells, mixed with those of species still living.

About fifty species are known from the Comoro Islands, 11 of which are Ennea.

The island of Bourbon contains 69 species, 9 of which are operculated; and that of Mauritius a richer fauna, including 28 species of Gibbus—of which form it may be considered the metropolis—8 of Omphalotropis, etc. *Gibbus Lyonetianus*, one of the most bizarre-looking of land shells, appears to be rapidly becoming extinct. The island of Rodriguez possesses a fauna resembling that of Mauritius. The Seychelles contain two large Helices (Stylodonta) and the singular slug *Mariella Dussumieri*. The genera Cyathopoma, Leptopoma and Helicina are representatives of Asiatic forms, as well as the species *Ennea bicolor* and *Helix similaris*—the two latter acclimated throughout this region.

11. Afro-Arabic Region.

The S. W. Highlands of Arabia (Yemen), which form a botanical province isolated by rainless deserts to the north, Abyssinia, the island of Socotra, and the African shore of the Gulf of Aden form a region but little known, but which differs sensibly from the African and Indian faunas. In Arabia and Socotra, Ennea, Vitrina, Buliminus, Opeas, Cæcilianella, Pupa, Cœlostele, Isidora, Clyclostoma, Otopoma, Lithidion and Melania are found. There are no Helices; Buliminus 14 sp.

The fauna of Abyssinia is curious alike for the absence of African genera, such as Ætheria, Iridina, Galatea, Achatina, Lanistes, and for the intrusion of forms from other regions. The latter include 2 species of Limicolaria, several European species (Succinea, Limnæa, Helix), some Buliminus, etc. There is not a single species of operculated land shells, but there are 2 Clausilia, 12 Pupa, 8 Vitrina, 9 Subulina; Paludina occurs, but no Ampullaria. There are 3 Uniones, a Corbicula and a Cyclas.

12. Indian Region.

This province has been very well studied, and the rich results are included in the magnificent "Conchologia Indica," by Hanley and Theobald, published in 1876. Among the most remarkable terrestrial genera may be cited: Anadenus 2 sp., Vitrina 12, Succinea 10, Lithotis 2, Nanina (sections Macrochlamys, Xesta,

Ariophanta) 50, Helix (sections Plectopylis, Plectotropis. Eurystoma, Trachia, Planispira, Corella, Oxytes) 21, Boysia 1, Streptaxis 4, Ennea 6, Buliminus 46, Cylindrus 5, Electra 53, Clausilia 3; and the following operculated forms: Cyclotus 2, Mychopoma 2, Cyathopoma 21, Spiraculum 3, Pterocyclos 6, Alycæus 53, Opisthopoma 5, Diplommatina 2, Nicida 6, Scabrina 1, Cyclophorus 29, Lagocheilus 1, Ditropis 3, Tropidophora 1, etc.: in all nearly 400 species. The fluviatile shells belong to the genera Limnæa, Planorbis, Ancylus, Camptoceras (special), Camptonyx (special), Valvata, Bythinia, Paludina, Amnicola, Stomatodon (special), Tricula (special), Melania, Canidea and Clea (fresh-water Buccinidæ), Paludomus, Ampullaria, Neritina, Navicella, Unio, Corbicula, Velorita (special), Cyclas, Pisidium.

The genera Tanysiphon, Scaphula (Arcidæ), Novaculina (Solenidæ), Stenothyra and Oncidium live in the estuaries. Finally Cremnoconchus appears to be a terrestrial Littorina.

The various provinces of the vast Indian peninsula show remarkable diversity in altitude, climate and vegetation, and the region might be subdivided, although it is throughout characterized by the presence of certain peculiar forms which rather trenchantly separate it from other provinces. That portion which undoubtedly presents the most distinctive features is the island of Ceylon, which, like most insular faunas, is particularly rich in species. 250 forms are recognized from this island, including 49 Nanina, 23 Cyclophorus, 16 Cataulus, and 38 Paludomus (in Paludomus mostly varieties only). Two of the groups of Helices, Acavus and Corilla, are peculiar to the island, Acavus including some of the most beautiful of the Helicidæ. Ceylon has, perhaps, quite as much claim to be treated as a distinct fauna, as several of the other regions of Woodward and Fischer.

13. Indo-Chinese Region.

This region includes Assam, Burmah, Aracan, Pegu, Cambodia, Siam, Malacca, Singapore, Pulo Penang, Annam, Laos, the islands of the Nicobar and Andaman groups in the Gulf of Bengal, etc. It is much richer in mollusks than even the Indian peninsula, the operculated pulmonates especially being astonishingly developed; such as Cyclophorus, Lagocheilus, Pterocyclos, Rhiostoma, Alycæus, Diplommatina, Pupina, Rhaphaulus, etc. The most abundant non-operculated pulmonates belong to the genera Nanina, Helix, Amphidromus, Hypselostoma, Electra, Clausilia, Vitrina, Streptaxis. The fresh-water gastropods are Paludina, Ampullaria, Melania, Pachydrobia, Lacunopsis, Jullienia, Canidea. The acephala are Unio, Pseudodon, Anodonta, Arconaia, Solenaia, Dipsas, Cyrena, Corbicula, Scaphula (fresh-water Arca) and Modiola, of which a species lives in Lake Tonli-

Sap. In the Unionidæ, some of the generic forms are closely allied to So. American genera, as Pseudodon to Monocondylæa, Solenaia to Mycetopus, Arconaia to Hyria. The Andaman and Nicobar Islands each possess many peculiar species.

14. Indo-Malaysian Region.

The islands of Sumatra, Java, Borneo, the Celebes, etc., form a natural insular region; to which the fauna of the peninsula of Malacca is quite as closely related as it is to that of the Indo-Chinese region to which it is attached. The section Amphidromus, of Bulimus, is the most characteristic form; but Nanina is largely distributed, and represented by its most beautiful species; Clausilia is found in Sumatra, Java and Borneo; the genera of operculated land shells are numerous; Melania predominates among the fluviatile mollusks.

The mollusks of this region are most nearly related to those of Indo-China.

But little is known of the mollusks of Sumatra; most of the described species being common to Borneo and Java. In Java 191 species have been collected, 14 of which are operculated, 82 fresh-water, 17 common to Sumatra.

Borneo, which is far from being completely explored, yields 167 species, of which 45 are operculated, 45 fresh-water. Of these 167 species, 19 live also in Java, 13 in Sumatra, 16 in the Indo-Chinese province, 18 in the Philippines; 100 species are peculiar to the island. The brackish-water mollusks are remarkable: *Pholas rivicola* burrows in floating logs used as landing places, twelve miles from the sea, up the Pantai River. The mangrove swamps abound with Cerithidea, Terebralia, Potamides and Quoyia; Auricula and Scarabus inhabit damp woods.

15. Philippine Region.

The extraordinary richness of these islands has been developed mainly by the researches of Cuming and Semper. The climate is equable, with a temperature like that of South China (66°–84°), woods are prevalent and the rains heavy—all circumstances favorable to the abundance of land shells. This region has been called the paradise of mollusks, and in fact, nowhere else upon the surface of the globe is there such a rich collection of gorgeously colored shells—classed as Helix or Bulimus according to the degree of elongation of the spire. It is supposed that, as in the West Indian Islands, the fauna of each island is largely peculiar to itself, but we do not possess the means of verifying this supposition. The list prepared by Kobelt comprises 586 species, 65 of which are operculate. There are 108 fluviatile gastropod mollusks. The Helices alone include about half the total number of species, and of these the characteristic

genus Cochlostyla has no less than 211 species. The bulimoid forms of Cochlostyla are many of them large and highly colored, under a thin, hydrophanous epidermis, almost like the bloom on a plum, and the bands become translucent when wetted. There are 50 species (or varieties) of Melania, 38 of Neritina; the bivalves consist of Batissa, 3; Corbicula, 7; Cyrena, 3; Anodonta, 1.

16. Austro-Malaysian Region.

This division includes the islands lying between Australia and the Philippines, that is to say: the Celebes, Moluccas, New Ireland, New Britain, New Guinea, and the Admiralty, Louisiade and Solomon Islands.

In these islands Helix is largely developed; the group Geotrochus being characteristic, although wanting in the Celebes; but these islands, situated at the eastern extremity of the region, have a fauna of ambiguous character, including with a number of special species, many which approach those of the Philippines and Malaysia.

In the Moluccas more than 100 species are known, 28 of which are operculated. In New Guinea there are 90 species, 35 of which are Helices of the sections Chloritis, Planispira, Papuina, and principally, Geotrochus. Leucoptychia and Perrieria are peculiar genera. The Louisiade Archipelago has yielded as yet but few shells; including 4 handsome species of Geotrochus, and a large Pupina. In the Admiralty Islands there are 44 species, according to Kobelt, including 25 Helices, of which 14 are Geotrochus. The Central Polynesian genus Partula is here represented by 4 species. The 64 species of New Ireland and New Britain include Geotrochus 4, Partula 2, Melania 13, Neritina 16. The fauna of the Solomon Islands and New Georgia is exceedingly rich: more than 160 species, have been described, and the number is constantly augmenting notwithstanding the difficulty of exploring countries peopled by anthropophagous tribes. Heliciform shells predominate; principally Geotrochus, 60 sp.; Trochomorpha, 21 sp., and Nanina. There are a dozen species of the group Placostylus (Bulimus) of which *B. Cleryi* is the most remarkable. Relationship with the Polynesian fauna is shown by the occurrence of species of Partula, Diplommatina, Pupina, Realia, Helicina; with the Austro-Polynesian fauna, by that of Placostylus.

17. Australian Region.

The Australian continent has only been partially explored for shells, those of the eastern coast being best known, whilst the west has so far yielded but few species—including many Bulimi. In North Australia are found Helices of the group Xanthomelon,

and a Geotrochus. Physa, Amphipeplea, Paludina, Melania, Cyrena and a Solenaia live in its waters: Amphipeplea being a characteristic genus. In Queensland, the Helices belong to the sections Panda, Trochomorpha, Pedinogyra, Hadra, Galaxias, Geotrochus, etc. New South Wales has a fauna less tropical than that of Queensland; Pupina diminishes in importance, and Helicina disappears. Three species of Athoracophorus occur, a slug essentially Australian; also several Unios. The Helices are largely represented and mostly of the same sections occurring in the other provinces. In Victoria and South Australia the Helices are mostly of the section Hadra. Paryphanta, a New Zealand genus, is represented by *P. atramentaria*. Tasmania has 115 species, 79 terrestrial and 36 fluviatile. Only ten of the terrestrial species are common to the Australian continent, and Pupa, Pupina, Helicina and Tornatellina, genera found in the south of Australia, are here absent. As in Australia, the fresh-water gastropods are numerous; among them is a species of the American genus Gundlachia.

18. Austro-Polynesian Region.

Includes the New Hebrides, New Caledonian and Viti Archipelagos, with a very remarkable fauna. Geotrochus disappears and Bulimi of the group Placostylus become predominant. The slug Athoracophorus, the heliciform carnivores Rhytida and Diplomphalus, a few species of Partula, etc., occur.

About 60 species are credited to the New Hebrides, and nearly 400 to New Caledonia and the Loyalty Isles, including 46 Placostylus, 27 Melampus, (an extraordinary development of Auriculadæ, for besides Melampus, there are) 7 Cassidula, 2 Plecotrema, a Pedipes, Marinula and Blauneria, 10 Scarabus and 5 Auricula, 4 Planorbis, 14 Physa, 7 Cyclophorus, 11 Hydrocena, 7 Truncatella, 14 Helicina, 27 Melanopsis, 15 Melania, 47 Neritina, 11 Navicella. The only bivalve is a Cyrena.

The Viti or Fiji Islands furnish over 125 species, mostly of the same generic types as in New Caledonia, but the species of the terrestrial mollusks are all different. The genus Omphalotropis, however, is present, with 10 species; whilst Melanopsis, having 27 species in New Caledonia is here entirely unrepresented. There are 14 Placostylus, one of the sections of which, Charis, containing *P. fulguratus* and *malleatus*, is arboreal, living in the palms, bananas and Pandanus.

19. Polynesian Region.

Fischer has formed two principal groups of the islands of the Pacific, which he calls: 1, The Sandwich or Achatinella group; 2, The Partula group—comprehending all the other islands. The latter, however, he subdivides into the occidental islands, situated

north of the equator (Mariannes, Pelew, Carolines, etc.), and the austral islands, south of the equator (Samoa, Tonga, Cook, Tahiti, Paumotus, Gambier, etc).

Throughout the entire region the terrestrial species are of small size; Placostylus, Geotrochus and Cochlostyla disappear. The heliciform shells belong to the genera Patula, Endodonta, Trochomorpha, Nanina, Microcystis, etc., whilst the operculated pulmonates are represented by Diplommatina, Realia, Pupina, Helicina. The terrestrial species are generally localized.

The Sandwich Islands. These contain nearly 400 nominal species, of which the three genera Achatinella, Auriculella and Carelia, closely related, are peculiar to this group. Achatinella alone has 288 species, or varieties, some of which are always dextral, others sinistral, and others again either dextral or sinistral. Limnæa is here sinistral. The progress of agriculture, disappearance of some of the indigenous trees, and introduction of cattle combine to diminish the Achatinellæ, some of the species of which are upon the verge of extinction.

The Partula Islands. In the Pelew Islands occurs a very curious fauna, characterized by numerous species of Diplommatina of the section Palaina. There are three Partulas.

The Mariannes or Ladrones contain 4 Partulas, etc. About twenty-five species, including a Partula inhabit the Carolines.

The Ellice and Samoa Islands appear to possess the same fauna, aggregating seventy-six species. The heliciform shells are of small size and belong to the genera Nanina (groups Microcystis, Trochonanina, Gastrodonta), Patula (Endodonta), Trochomorpha, etc. The genus Partula contains five species; there are four Cyclophorus (group Ostodes). The fresh-water shells include Melania, 11 sp., Neritina 13 sp., Navicella, 4 sp.

The Tonga Islands have about 50 species, a few of which are common to the Samoa and Viti Archipelagos. The Cook and Hervey Islands have 16 species of Patula, Endodonta, 3 of the curious genus Diadema, etc.

The Tahiti or Society Islands possess a very rich molluscan fauna, embracing 130 species. This is the metropolis of the genus Partula, which numbers 45 species here, besides the few found in other islands. There are 16 species of Endodonta, 10 of Realia, 10 of Helicina, 6 Melania, 7 Neritina, etc. Very little is known conchologically of the Paumotus and Gambier Islands, and not much more of the Marquesas; each of these groups contains a few Partulas.

20. New Zealand Region.

Although the islands of New Zealand contain a large number of peculiar mollusks, there are generic analogies with Australia in the occurrence of Paryphanta, Athoracophorus and Rhytida,

and with New Caledonia in that of Placostylus, Melanopsis and Rhytida. The genus Latia is peculiar. The moist and equable climate of these islands, which have a mean temperature of 61°–63°, is favorable to the existence of numerous land snails. The heliciform species number 58, whilst the operculates include only two Cyclophorus, a Paxillus, Diplommatina, Realia, etc. There is a Physa of the Australian group Ameria, 5 Unionidæ, and a Potamopyrgus or spiny Hydrobia, resembling West Indian and South American species. Hutton's catalogue of the land and fresh-water species, published in 1880, contains 128 names. The genus Partula is not represented. The Aucklands, Campbell, Norfolk and Kermandec Isles belong to this Province, but each contains one or more special species.

21. Patagonian Region.

Fischer very properly unites under this name the Argentine and Patagonian Regions of Woodward. The region is an extensive one, yet the fauna is very meagre, including only 174 species; 79 being terrestrial, of which not a single one is operculated. More than half the species are fluviatile. The physical condition of these countries explains the anomalous distribution of the mollusca. The pampas, or great plains of Patagonia, are dry and rainless nearly all the year; the vegetation which springs up during the light summer rains, becomes converted into natural hay for the support of the wild animals. In Fuegia the mean temperature is 33°–50°, and there is rain and snow throughout the year; yet the bases of the mountains are clothed with forests of evergreen beech. The fertile portion of the Argentine States is separated from Bolivia by the wide plains of the Great Desert or northern prolongation of the pampas; and all the eastern part has been submerged at a recent geological period; the only promising districts are Paraguay and the eastern declivities of the Chilian Andes.

The characteristic terrestrial forms are Bulimi, with apertures contracted by teeth, sections Plagiodontes, Odontostomus, and Macrodontes; Chilina, a fresh-water pulmonate allied to Limnæa, but with toothed aperture, and peculiar to South America, furnishes 5 species; the bivalve genus Monocondylæa, also South American in distribution, has 5 species; there are 24 Unio, 17 Anodonta, and species of the related South American genera Leila, Castalia, Mycetopus, Byssanodonta. *Azara labiata*, an estuary shell related to Corbula, is found in the La Plata River. Of fresh-water gastropods, Planorbis has 6 sp., Ampullaria 9 sp., Paludestrina 11 sp. No Melania or Paludina. The Falkland Islands are 300 miles east of Patagonia. The only recorded shells are 2 species of Paludestrina. A single species, *Helix Hookeri* inhabits Kerguelen Island.

22. Chilian Region.

The northern part of Chili belongs to the same physical region with Peru, consisting of dry and rainless plains. Here the land snails are few and small, and only seen after the dews. At Valparaiso rain is abundant during the three winter months, and the southern coasts are luxuriantly wooded and extremely wet. The fauna is characterized by the abundance of Bulimi, belonging to the sections Borus, Scutalus, Peronæus, and Plectostylus, all South American groups. There are but few Helices, one of which *H. laxata* attains a large size, and recalls by its form the *H. lanx* of Madagascar. There are only two operculated species. Among the fluviatile shells Chilina and Unio are largely represented. One of the former and a Succinea are peculiar to the island of Chiloe. The Islands of Juan Fernandez have a fauna completely restricted, numbering over 20 species, all terrestrial, mostly Helix and Succinea.

23. Peruvian Region.

The long and narrow tract between the Andes and Pacific, extending from the equator to 25° S. lat. forms a distinct though comparatively unproductive province, including the coast of Ecuador, Peru and Bolivia. It is warm and almost rainless; the clouds discharge themselves on the east side of the Andes, and rain is so rare on the west coast that in some parts it only falls two or three times in a century. In Peru, during great part of the year, a vapor rises in the morning, called the "garua;" it disappears soon after midday, and is followed by heavy dews at night. There are a few helicoid shells, some of them of very peculiar appearance, but the Bulimi are predominant and include many species. The reappearance here of a group of the Mediterranean genus Clausilia, with 7 species, is a notable fact. There are 3 Helicinas. Chilina has disappeared, but there are 3 Ampullaria. Planorbis is well represented, as is Anodonta; besides which we find Ancylus, Limnæa, Physa, Cyclas, Cyrena.

The fauna and flora of the Galapagos Islands are peculiar, although related to those of South America. The only known shells are 18 species of Bulimus, forming the section Nesiotes; and of these, 10 species are restricted to single islands of the group.

24. Columbian Region.

This includes the rainy and wooded States of New Granada and Ecuador (except the Pacific coast of the latter), the elevated and nearly rainless province of Venezuela, with a flora like that of the higher regions of the Andes; and Guiana, where the forests are most luxuriant, and rain falls almost daily (amounting to 100 or even 200 inches in the year). Most of the low lands, like

those of the Mexican Province, belong to the Cactus Region of botanists, and have a mean temperature of 68° to 84°. Land shells are abundant in the forests and underwood of the lower zone of the mountains, where the temperature is 10° less, and the rains more copious. These diverse countries are characterized by the abundance of bulimiform shells, Bulimus, Bulimulus, Otostomus, Orthalicus, etc; of the operculated genus of Cyclotus, including some fine, large species, and of Ampullaria. The heliciform groups Labyrinthus, Isomeria and Solaropsis are numerous. Finally, the following characteristic genera occur: Guestieria, Rhodea, Bourcieria, Mulleria. The American Clausiliæ are represented by a few species, but their metropolis is the Peruvian Region. There are a few Streptaxis—a Brazilian genus, several species of which, nevertheless, occur in the tropical countries of Asia and Africa. The genus Mulleria, which lives in the Rio Magdalena may be considered the analogue of the fresh-water oyster Ætheria of Africa. The Melanians mostly belong to Hemisinus, a South American group extending into Brazil, and having its northern limit in the West Indies.

25. Brazilian Region.

"The region of palms and melastomas," extending from the Amazon to the southern tropic, is one of the richest zoological provinces; it includes Brazil and the districts of Peru, Ecuador and Bolivia east of the Andes. A large part of the region is mountainous and rainy and densely wooded, but intersected by extensive plains (Llanos); some grassy and fertile, others dry, rocky and rainless—especially in the South. It is watered by numerous streams—the affluents of the Amazon and Plata.

The dominant character of the molluscan fauna is the importance of bulimiform snails, and the contrasting scarcity of the heliciform types; thus of about 300 species of terrestrial and fluviatile shells of the region, the Bulimi number 108, the Helices only 14. The principal forms are: Streptaxis 17 sp., Anostoma 4 sp.; Helix, of sections Ophiogyra, Solaropsis, Geotrochus, Labyrinthus; Bulimus, of sections Macrodontes, Odontostomus, Tomigerus, Pelechilus, Anthinus, Pachyotus, Strophochilus, Borus, Orphnus, Otostomus, Liostracus, Anctus, Eudioptus, Rhinus; Peltella; Simpulopsis; Megaspira; Obeliscus; Dorissa; Hemisinus; Ampullaria; Hyria; Castalia; Leila.

The interior streams contain but few gastropod mollusks. There are Ancylus 3, Physa 1, Doryssa 3, Hemisinus 17, Melania 6, Ampullaria 18, Neritina 2. The Unionidæ, etc., number nearly 50 species, including the South American genera Hyria, Mycetopus, Castalia, Leila, Monocondylœa. Besides the group Borus, containing the largest species of Bulimi, the other

Brazilian forms are those in which the aperture is dentate, angulated, or auriculiform.

26. Mexican Region.

Includes the Republic of Mexico and Central America; Lower California also belongs to it zoologically. This extensive country comprises three physical regions; the comparatively rainless and treeless districts of the west; the mountains or high table-lands with their peculiar flora; and the rainy wooded region that borders the Caribbæan sea. It is divided by Fischer into four geographical subregions: 1. Subregion of the Gulf, comprising the coasts of the Gulf States (Tamaulipas, Vera Cruz, Tabasco, Campeche, Yucatan), the isthmus of Tehuantepec and Central America; 2. Subregion of the centre, formed of the temperate and cold districts (Puebla, Mexico, Zacatecas, etc.); 3. Subregion of the Pacific; 4. Subregion of Lower California.

The Subregion of the Gulf is characterized by the genera Strebelia, Streptostyla, Petenia, Glandina, Xanthonyx, Helix (groups Odontura, Geotrochus, Corasia), Cœlocentrum, Eucalodium, Cylindrella, Macroceramus, Orthalicus, Bulimulus, Opeas, Spiraxis, Subulina, Vaginula, Aplecta. All the Mexican operculated land snails inhabit this subregion: Cyclotus, Cyclophorus, Tomocyclus, Choanopoma, Adamsiella, Tudora, Cistula, Chondropoma, Helicina (36 species); as well as the genera Ceres and Proserpinella of the family Proserpinidæ: most of these genera are West Indian types. The Melanian genus Pachycheilus is peculiar to the region and its metropolis is Central America. A number of Ampullaria occur in the southern portion, as well as a single species of the South American genus Hemisinus, in Guatemala. There are numerous fine species of Unionidæ and a few Cyrenidæ.

The colder central region contains a very much less extensive fauna. There are a few Glandina, a Helix of the Pomatia section, *H. Humboldtiana*, and several small species of the Polygyra group; Holospira replaces the Cylindrella and Eucalodium of the warmer regions. A single Melanian, and a few Physa, Limnæa and Planorbis constitute the fluviatile gastropods.

The Pacific subregion is rather bare of mollusks also, but includes some characteristic fluviatile forms; the large *Aplecta aurantia*, the only North American Corbicula, 4 Cyrena, etc.

In Lower California the existence of 12 species of Bulimulus shows the affinity of the fauna with that of Mexico and of Western South America; on the other hand the Helices, few in number, are of Californian types. Berendtia is restricted to this subregion; the paucity of its species corresponds to the desert nature of its soil.

The Mexican fauna is characterized by the existence of num-

erous carnivorous land snails, nearly 100 species of which have been catalogued by Crosse and Fischer, an assemblage of agnathous gastropods nowhere else equaled. Bulimulus contains 74 species. The following genera are special to this province or have their metropolis here: Strebelia, Glandina, Xanthonyx, Cœlocentrum, Eucalodium, Holospira, Berendtia, Tomocyclus, Ceres, Proserpinella.

27. Caribbæan Region.

The West Indian Islands offer the interesting spectacle of a succession of localized faunas of incomparable richness, occupying contiguous islands. The climate appears to be very favorable to the multiplication of snails, the mean temperature being 59°–78°, the annual rain-fall usually over 100 inches. The most remarkable character of the mollusca of this region is the great proportion of pneumonopomata or operculated land shells, as well as the variety of generic types represented, some of which, such as Geomelania, Chittya, Jamaicia, Licina, Choanopoma, Ctenopoma, Diplopoma, Stoastoma, Lucidella, do not exist on the adjacent American continent. The operculated mollusks constitute one-half of the entire number of mollusca of Jamaica and Cuba, and a smaller, but relatively large proportion in the other islands.

A few West Indian shells are acclimated in the South of Florida, eighteen species occur in Mexico and Yucatan, and several are common to the Lesser Antilles and Venezuela; on the other hand several species of the surrounding faunas have been introduced, leaving the enormous number of 1200 or 1300 species, peculiar to the islands, many of which have an extremely limited area of distribution, being sometimes confined not only to a single island, but to a single valley, of the mountainous districts.

The West Indies may be grouped in accordance with the character of their faunas as follows: 1, Bahamas; 2, Cuba and Isle of Pines; 3, Jamaica; 4, Haiti and Navassa; 5, Porto-Rico, Viéque, St. Croix, St. Thomas, St. Johns, Tortola, Anguilla, St. Martin, St. Bartholomew, Sombrero; 6, Guadeloupe, Martinique, Dominica, St. Christopher, Antigua; 7, St. Vincent, St. Lucia, Barbados, Grenada, Trinidad; 8, Windward Islands, Curaçoa, Buen-Ayre.

This grouping mainly corresponds with the depth of the surrounding water, those islands which partake of a common fauna being generally separated by water of no great depth, so that at some former period of the world's history they may have been connected or at least approximated more closely than at present. —Bland, Proc. Am. Philos. Soc., xii, 56.

1. *Bahamas.* Out of 43 species, 29 are restricted to this archipelago, including all the operculates. The continental

genus Schasicheila has a single species, and is nowhere else represented in the West Indies. The Caribbæan group Strophia of Pupa has 8 species.

2. *Cuba and Isle of Pines.* More than 600 species have been described, of which 250 species are operculates. These are all, with the trifling exception of 53, confined to the island; all the operculates except the Truncatellæ are thus restricted. The dominant genera are: Strophia (19 out of 36 known species), Macroceramus (31 out of 51), Cylindrella (93 out of 140), Megalomastoma (12 out of 29), Chondropoma (51 out of 100), Cistula (15 out of 42), Ctenopoma (23 out of 26). There are also 17 species of Glandina, 76 of Helix (largely of special groups,) 30 of Stenogyridæ, 10 of Succinea, 78 of Helicinidæ, etc. Fresh-water shells, as in the other islands, are scarce; there are 39 gastropods, 6 lamellibranchiates, including the only two species of Unio in the West Indies.

3. *Jamaica.* This island is almost as rich in mollusks as Cuba, containing 500 species, nearly half of which are operculates. The genera Geomelania, Chittya and Jamaicia are peculiar to the island, and Stoastoma and Lucidella each have only a single extra-limital species. The other characteristic mollusks are: Adamsiella (12 out of 17 known species), Tudora (17 out of 33), Helices, nearly 100 species (including the groups Sagda, Pleurodonta, Caracolla, Dentellaria), the groups Lia and Casta of Cylindrella, numerous Cyclotus, etc. The genera Strophia (Pupa), Licina and Magalomastoma found in Cuba are not here represented. Only 41 Jamaica species occur in other localities.

4. *Haiti and Navassa.* Haiti has about 200 species, of which 70 are operculated, and 2 (Planorbis) fluviatile. The island has not been so thoroughly explored for mollusks as either Cuba or Jamaica, and will probably yield much richer results than those already recorded. There are no restricted genera, but those most largely developed are: Glandina, etc., 10, Helix 43, Macroceramus 10, Cylindrella 30, Stenogyra 12, Choanopoma 12, Helicinidæ 29. There is a single species of the Jamaica group Lia.

The guano island of Navassa has so far furnished only three species, all peculiar.

5. *Porto Rico, and neighboring Islands.* About 120 species are recorded; among them the genus *Gæotis* is restricted to Porto Rico, where lives also the only West Indian Clausilia, of the group Nenia. The operculates are less developed in this island than elsewhere, the genera Tudora, Cyclostoma, Ctenopoma, Geomelania, Jamaicia, Adamsiella, Lucidella, Diplopoma and Trochatella being absent.

6. *Guadeloupe, Martinique and neighboring Islands.* The characteristic group is Dentellaria (Helix), several species of

which have a somewhat extensive distribution. Gaudeloupe has 68 species, Dominica 20, St. Kitts 6, Martinique 50, etc. *Amphibulina patula* appears to have become extinct a few years since in Guadeloupe, but still lives in Dominica and St. Kitts.

7. *St. Lucia, St. Vincent, Barbados, Grenada, Tobago, Trinidad.* These islands differ radically from those which precede them by the introduction of South American Bulimi. This continental character is more pronounced in the islands nearest the Venezuelan coast. (The characteristic Bulimi of the other islands are of very few species, but two or three of them have a much more extensive distribution than the other land shells.) There are at St. Lucia, 3 species, at St. Vincent 15, at Barbados 30, at Grenada 14, at Tobago 1, at Trinidad 52. In the latter island, nearly half of the species are of continental, principally Venezuelan origin, including the large *Bulimus* (*Borus*) *oblongus*, *Ceratodes* (*Ampullaria*) *cornu-arietis*, *Streptaxis deformis*, etc. Here is found the only West Indian species of Anodonta.

8. *Windward Islands.* Very few species are known: the curious genus Ravenia is special to the islet Los Roques.

The distribution of the West Indian shells presents some interesting peculiarities. Thus the group Strophia lives only in the Bahamas, Cuba, Haiti, Porto Rico, St. Croix and Curaçoa, not in the intermediate islands; Simpulopsis has been found at Haiti, Porto Rico and Trinidad; Amphibulina occurs only in the Lesser Antilles; Stoastoma, Trochatella, Lucidella, Proserpina, Ctenopoma, on the contrary, are restricted to the Greater Antilles; Gundlachia has only been found in Cuba and Trinidad; Cylindrella, Bulimulus, Glandina, Macroceramus, Helicina, Cistula, Chondropoma, Choanopoma and Tudora are found in nearly all the islands; there are only 3 Unionidæ, 2 of them restricted to Cuba, the other to Trinidad.

28. American Region.

The eastern and central portions of the United States constitute a vast and thickly populated molluscan region: Florida, Louisiana and Texas are included in it, although a few of the species are derived from the neighboring Mexican and Caribbean faunas.

Woodward and Binney have divided this region into provinces which, I perfectly agree with Dr. Fischer, have very slight claims to recognition from any peculiarities of their several faunas; whilst the region as a whole certainly presents a large assemblage of forms originating within, and in many cases confined to its boundaries. The Helices are not very numerous, and, in contradistinction to those of Europe and of California are mainly unicolored shells. A large proportion of them are with toothed aperture. The following are peculiarly American groups; Mesomphix,

Gastrodonta, Helicodiscus, Polygyra, Stenotrema, Triodopsis, Mesodon, etc. Yet few as the Helices are, they outnumber the Bulimi and Pupæ, which are mostly minute, and also unicolored. Succinea is well developed, and there are a few slugs. Only two species of operculates are native to the region.* On the other hand the development of the fluviatile forms is enormous, and is unequaled in any other region. The numerous large rivers and lakes are not only well populated, but in many cases each river system has forms restricted to itself.

The so-called American Melanians belong to a group entirely restricted to the United States, and form a distinct family, Strepomatidæ. The animal differs from the true or oriental Melanians by the absence of a fringed border on the mantle and by their oviparous reproduction. In 1875, I published a monograph of the Strepomatidæ, containing nearly 450 species after making wholesale reductions on the number of described species. Since the preparation of that monograph, a few additional forms have been characterized. The family includes 9 generic groups: Io 3 species, Pleurocera 83, Angitrema 12, Lithasia 13, Strephobasis 9, Eurycælon 10, Goniobasis 255, Schizostoma 28, Anculosa 31. Most of these are Southern species, the Alabama River and its tributaries, the Coosa and Black Warrior, being the most thickly and variously populated. The waters of the N. England, Middle and Northwestern States contain but few species, yet those which occur have usually a much more extended distribution than the Southern species. The genus Io is entirely confined to the Tennessee River and its tributary streams, the genus Schizostoma to the Coosa River. Few of these shells occur west of the Mississippi River. The development of Naiades is equally extraordinary with that of the Strepomatidæ. Mr. Lea, who has for half a century devoted unceasing attention to this very difficult family, admits 645 American species, of which are Unio 559, Margaritana 28, Anodonta 58; most of them first characterized by himself. The distribution of the Unionidæ does not differ much from that of the Melanians; where the latter are most plentiful, the former also abound.

Limnæidæ and Viviparidæ are both largely developed; the species of the first family are particularly numerous, but so polymorphous that it is very difficult to define the species. The American Viviparidae include the special types Tulotoma, and Lioplax. The European Paludina is represented by *P. lineata*, a species which has been considered identical with its

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* The limits of this work forbid pursuing more in detail the geographical distribution of American terrestrial mollusks: a valuable paper upon this subject by Mr. Wm. G. Binney, is contained in Bull. Mus. Comp. Zoology, iv, 17.

European analogue, *P. vivipara*, but which differs in possessing four colored bands, whilst the latter has but three. Several species of Limnæa and Planorbis are identical with European and Siberian species, so that these species have a wide distribution. One of the Unionidæ also, the *Margaritana margaritifera* occurs in all the colder waters of N. America, as well as in Europe and Siberia.

There are, in the United States, 2 species of Cyrena, numerous Cyclas and Pisidium, and the peculiar genus Rangia or Gnathodon, which inhabits the lagoons of the Gulf States.

The prodigious multiplicity of individuals of the fresh-water species is a fact as remarkable as the quantity of specific forms. The bottoms of some lakes are formed of such thick deposits of shells that they are gathered for agricultural top-dressing. At Muscle Shoals on the Tennessee River, navigation is actually impeded by the accumulation of Unionidæ. The city of Mobile, Alabama, is built upon a bank of Rangia; the road from New Orleans to Lake Pontchartrain, 6 miles long, is constructed of Rangia shells found at the eastern extremity of the lake, where the bed of shells measures a mile in length, by 200 feet wide, with a depth or thickness of 15 feet.

Fischer includes the Bermudas in the American rather than in the West Indian region, distinguishing it from the latter by the absence of Cyclostomidæ or operculated land shells. Only 19 species are known, 9 of which are West Indian and 2 European, the rest peculiar. 6 of these species occur in Texas and Florida but may be considered as acclimatized rather than native forms.

29. Californian Region.

The Pacific slope from Alaska to San Diego is inhabited by a fauna very distinct from that of the American Region. The Helices are highly colored, and more like the European groups and are numerous—principally Arionta, Aglaja, Selenites. The Unionidæ and Melanians are very rare, but fresh-water pulmonates abound, and some of them are of Eastern American species. There are no operculated land shells. The principal genera, besides those already enumerated, are Prophysaon, Ariolimax, Binneya, Hemphillia, Pompholyx, Carinfex, Tryonia, Cochliopa, Fluminicola. The Tryonia are all dead shells, occurring numerously upon the surface of the ground in the Colorado Desert. Similar shells are found living in Lake Baikal, Siberia.

30. Canadian Region.

Fischer has constituted this region for British America, Alaska, Greenland and a part of New England, and states that it is characterized by a mixture of American and European forms. He has divided it into 5 subregions.

I think that this should be considered rather as a portion of the American region, as it has no faunal peculiarities whatever. Many of the species, especially in the northern portions of the territory, are identical with European species, but then a considerable number of them are known to occur in North Asia also; they are, in fact, circumboreal. There are a few peculiar species, principally in Greenland and Iceland; both land and fresh-water shells being included in these, but no Melanian or Unio.

The question of the direction whence species common to the old world have been introduced into America, has not been decided, although, with the increase of our knowledge of Asiatic localities and species, it is becoming more probable that such forms have usually come thence. This view is strengthened by the occurrence of representatives of some of the Californian fluviatile forms in Lake Baikal. On the other hand, the ancient intercourse of Europe with Iceland, Greenland, New England, etc., cannot have failed to introduce accidentally a crowd of species; some of which, indeed, are known to have spread rapidly within a short period. Thus, the great snail, *Limax maximus*, has within a very few years spread from Philadelphia, where it first became acclimated in cellars, to New York and other cities; adopting subterranean habits in this country rather than inhabiting the surface of the earth, where the atmosphere would be too dry for its existence; it is now a commonly occurring species. Identical species may have been introduced both from the West and East, if of decidedly European type, but there are species, as the Limnæans, for example, which may as well have originated here and thence spread to the old world. Finally, we do not know that identity of specific or structural character is conclusive as to identity of origin.

HYPSOMETRICAL DISTRIBUTION OF LAND AND FRESH-WATER MOLLUSKS.

Mollusks are subject to conditions of existence varying according to altitude. As plants change according as they are submitted to the changing climates of different elevations, so shells are necessarily subject to like influence, some species never ascending beyond a certain height, others living entirely in mountainous regions. Whilst in Europe the elevation beyond which mollusks cannot exist is about 8000 feet, in America and Asia they are collected at nearly double that altitude.

In examining the mollusks of the Pyrenees, the Alps and Auvergne, the following are the results reached:

1. Lower Valleys. From the sea level to 3000 feet altitude

mollusks are very numerous, the fluviatile genera being entirely confined within this limit.

2. From 3000 to 4500 feet. This is the greatest height attained by a number of species of Helix, Hyalina, Vitrina, Pupa, Clausilia, etc.; some of which are found also in the lower valleys.

3. From 4500 to 6000 feet. Fischer has called this the zone of *Helix memoralis*, which occurs no higher, and which is found on rocks and wooded heights. In the Alps the same mollusks occur at a greater altitude than in the Pyrenees and Auvergne: thus *Helix arbustorum*, *hispida*, *Hyalina diaphana*, *Cionella lubrica*, having their upper limit within this zone in the Alps, in the other regions do not attain beyond 3000 to 4500 feet.

4. From 6000 to 8000 feet. The number of mollusks is much reduced, the species decidedly Alpine in character. The relation between the distribution of terrestrial mollusca and that of the plants on which they feed, is of course very intimate; thus in the Higher Kabylia, Aucapitaine's observations have resulted in establishing three zones of distribution for mollusks, namely: 1, that of the ashes, olives and pomegranates (450 to 2100 feet); 2, that of the oaks and pines (2100 to 3600 feet); 3, that of the cedars and green turf (3600 to 7200 feet). At Guadeloupe, West Indies, *Succinea Sagra* and *Homalonyx unguis* are found on the lowest lands; *Stenogyra octona*, *Leptinaria lamellata*, *Opeas Caraccasensis* occur no higher than 250 to 300 feet; *Bulimus exilis*, 600 feet; *Helix lychnuchus*, *dentiens*, *Josephinæ*, *pachygastra*, occur in forests at 900 to 1200 feet; *Pellicula appendiculata* lives in the region of palms, between 1800 and 2100 feet; *Bulimus limnoides* and *chrysalis* are abundant between 2000 and 2500 feet among roots; finally *Bulimulus Lherminieri* exceeds 2500 feet.

Arthur Morelet has established five molluscous zones for Peru and Bolivia, as follows: 1, Maritime Region, up to 2000 feet; 2, Region of the Montaña, from 2000 to 5000 feet; 3, Temperate Region, from 5000 to 8000 feet; 4, Cold Region, from 8000 to 12,000 feet; 5, Icy Region, from 12,000 to 16,000 feet. Within this latter region occur the following: *Limax Andecolus*, *Bulimus culmineus*, *B. nivalis*, *B. ochraceus*, *B. Yanamensis*, *B. Weddelli*, *Pupa Paradesi*, *Planorbis montanus*, *P. Andecolus*, *Paludestrina Andecola*, *P. culminea*, *Cyclas Forbesi*. The fluviatile mollusks enumerated occur in Lake Titicaca, the altitude of which is nearly 13,000 feet.

Mexico may be divided into three zones: 1, Tropical, up to 2500 feet; 2, Temperate, 2500 to 5000 or 6000 feet; 3, Cold. Among the species of the cold zone are: *Bulimulus Ghiesbreghti*, *B. sulcosus*, *Helix Humboldtiana*, *Glandina coronata*, *G. Orizabæ*, *Planorbis tenuis*, *Limnæa attenuata*. The two latter inhabit the Lake of Mexico, at over 7000 feet altitude.

A few Asiatic species have been collected at great heights.

Helix (Plectopylis) Shiroiensis, over 9000 feet. India.
Buliminus vibex, 7000 feet. India.
Buliminus nivicola, 14,000 feet. India.
Buliminus ornatus, 14,000 feet. India.
Nanina liratula, 6000 feet. Ceylon.
Stenogyra latebricola, 7000 feet. Landoura, Bengal.
Limnæa Hookeri, 18,000 feet! Landoura, Bengal.
Anadenus Schlagintweiti, 16,500 feet. India.

In Polynesia, *Helix bursatella*, a small species, lives at Tahiti between 2000 and 5000 feet altitude.

In examining the faunas of distant mountainous regions of Europe, we find identical or representative species, which, nevertheless do not occur in the intervening plains: for example, *Pupa megacheilos*, Italy and Pyrenees. *Helix arbustorum*, Alps; and *H. Xatartii*, Pyrenees. *Helix ciliata*, Alps; and *H. Beccarii*, Abyssinia. On the other hand some of the mollusks of cold countries are found also in more southern regions, but at a greater elevation, so that the conditions of temperature and of vegetation are reproduced; thus *Vertigo alpestris* inhabits Scandinavia, and occurs again, upon the Alps only, in Switzerland.

These facts have a great importance in connection with a just appreciation of the physiognomy of the quaternary fauna of a determined region.

As to the bathymetrical distribution of lacustrine mollusks, we know absolutely very little. The Lake of Geneva has a maximum depth of 1100 feet, with a uniform and constant temperature at all depths. Some crustaceans found at the bottom of the lake are blind, but the Limnæans have their eyes normally pigmented. Forel says: The deep fauna of the lake consists of a few species belonging to the most of the classes of animals inhabiting fresh water. A certain number of genera and families represented in the littoral fauna appear to be wanting to the abyssal; but there are no generic types belonging exclusively to the latter. Some species of the abyssal fauna, however, are different but analogous to superficial forms—differences which may be attributed to adaptation. Forel and Brot state that the pulmonary chamber of *Limnæa abyssicola* contains no air at the moment when it is taken from the water; but preserved in a jar, the animal behaves like its congeners, coming to the surface to respire, and passing entire hours out of the water. The abyssinal Pisidiums of the Lake of Geneva and of other Swiss lakes have the following characters in common, their minute size and enlarged beaks, characters which are similar to *P. abyssicola* of Lake Superior.

In Lake Baikal remarkable results have been obtained by an exploration of its depths, in making known fauna essentially different from that of the surface. Messrs. Dybowski and Godlewski obtained at or within 10 mètres of the surface, the following species: *Valvata Baicalensis*, *V. Grubii*, *Baicalia Angarensis*, *B. elata*, *Choanomphalus valvatoides*, *C. Schrencki*, *Ancylus Sibiriens*, *A. Troscheli*, Unio sp.

Between 10 and 100 mètres they dredged *Hydrobia Martensiana* and *H. maxima*. Commencing with 100 mètres *Choanomphalus Maacki* was found. Finally, between 300 and 350 mètres were obtained the following strange forms: *Choanomphalus Maacki*, *Baicalia pulla*, *Godlewskia turriformis*, *Trachybaicalia carinato-costata*, *T. costata*, *T. carinata*, *T. contabulata*, *T. Wrzesnowski*, *Dybowskia ciliata*, *D. Duthiersi*. Curiously enough, some of these exclusively deep-water forms are closely related to the fossilized shells of the genus Tryonia, occurring in countless myriads on the surface of the dried basin of the Colorado Desert of North America.

List of important recent works and papers upon the geographical distribution of the mollusca.

No attempt has been made to render the following list complete; only some of the most useful or recent publications upon each fauna are enumerated. Woodward's and Fischer's "Manuals," both contain many lists of species characteristic of the various geographical provinces: these may be consulted with advantage by those who are acquainted with the species; to others they are simply names without import.

MARINE PROVINCES.

I. *Arctic Province*:—

Sars. Mollusca regionis articæ Norvegiæ. Christiania, 1878.

Friele. Jan Mayen Mollusca, 1877.

Middendorff. Malacozoologia Rossica. St. Petersburg, 1847.

II. *Boreal Province*:—

Gould. Report on the Invertebrata of Massachusetts, 2d. Edit. Boston, 1870.

Dawson. Canadian Naturalist, iii, 158. (Gulf of St. Lawrence).

Verrill. Report of U. S. Fish Commissioner. Washington, 1871–2; 1879.

Verrill. Transactions of the Connecticut Academy, v.

III. *Celtic Province*:—

Jeffreys. British Conchology. 5 vols. London, 1862–1869.

IV.—*Lusitanian Province*:—

Weinkauff. Die Conchylien des Mittelmeeres. 2 vols., 1867–1868.

Hidalgo. Moluscos marinos da España, Portugal y las Baleares.

Drouet. Mollusques marins des iles Açores, 1858.

D'Orbigny. Mollusques des Canaries, 1839.

Fischer. Essai sur la distribution geographique des Mollusques du littoral océanique de la France, 1878.

MacAndrew. Report on the Marine Testaceous Mollusca of the Northeast Atlantic and neighboring seas. Brit. Assoc., 1856.

V. *Aralo-Caspian Province*:—

Eichwald. Fauna Caspio-Caucasica, 1841.

VI. *W. African Province*:—

Dunker. Index Moll. Guineæ, 1853.

Reibisch. Malakozoologische Blätter, 1865. (Cape Verd Is.)

Rochbrune. Nouvelles Archives du Museum, iv, 1881.

VII. *S. African Province*:—

Krauss. Die Südafrikanischen Mollusken, 1848.

Vélain. Archives Zool. Experimentale, vi (Islands of St. Paul and Amsterdam).

VIII. *Indo-Pacific Province*:—

Deshayes. Conchyl. de l'Ile de la Réunion, 1863.

Liénard. Catalogue de la faune malacologique de l'Ile Maurice, 1877.

Dufo. Moll. des Iles Séchelles et Amirantes, 1840.

Langdon. Shells of Ceylon. Quart. Jour. of Conch., 1875.

Fischer and Crosse. Faune malacol. de Cochinchine, Jour. de Conchyl., 1863–1864.

Brazier. Jour. of Conch.; 186, 1879 (Fitzroy Island, N. Australia).

Canefri. Ann. Mus. Civico de Genova, 1874–1877. (Papuan Islands.)

Vaillant and Fischer. Jour. de Conchyl., 1865. (Red Sea.)

Issel. Malacologia del Mar Rosso, 1869.

MacAndrew. Annals and Mag. of Nat. Hist., 1870 (Red Sea.)

IX. *Australo-Zelandic Province*:—

Angas. Proc. Zool. Soc. London, 1865, 1867.

Menke. Moll. Novæ Holl. spec., 1848.

Hutton. Manual of the New Zealand Mollusca, 1880.

Brazier. Proceedings of the Linnean Society of New South Wales.

Tenison-Woods. Proceedings of the Royal Society of Tasmania.

X. *Japonic Province*:—

Lischke. Japanische Meeres Conchylien (and supplements), 1869–1875.

XI. *Aleutian Province*:—
Schrenk. Reisen und Forschungen im Amur-Lande. 1867.
Crosse. Jour. de Conchyl., 3d Ser., xvii, 101, 1877. (Behring's Straits).
XII, XIII. *California and Panamic Provinces*:—
Carpenter. Supplementary Report on the present state of our knowledge with regard to the Mollusca of the West Coast of North America (Brit. Assoc. 1863–1864). First Report (Brit. Assoc. 1857.) [The 2d report was republished, with other papers by Carpenter, as "The Mollusks of Western North America." Smithsonian Institution, Washington, 1872.]
Adams. Catalogue of shells collected at Panama, 1852.
Carpenter. Mazatlan Catalogue. London, 1857.
XIV, XV, XVI. *Peruvian, Magellanic* and *Patagonian Provinces*:—
D'Orbigny. Voy. dans l'Amerique meridionale, Mollusques, 1837–1840.
Crosse. Jour. de Conchyl., xxv, 1877. (Kerguelen Isl.)
XVII. *Caribbean Province*:—
D'Orbigny. Mollusques de Cuba, 1855.
Mörch. Synopsis molluscorum marinorum Indiarum occidentalium (Malakozoologische Blätter, 1874–1877).
Krebs. West Indian Marine Shells, 1864.
XVIII. *Transatlantic Province*:—
De Kay. Zoology of New York, Mollusca, 1843.
Calkins. Marine Shells of Florida (Proc. Davenport Acad. of Sciences, 1878).
Gould. Invertebrata of Massachusetts, 2d Edit., Boston, 1870.
Verrill. Transactions Conn. Acad., v

TERRESTRIAL PROVINCES.

I. *Septentrional Region*:—
Jeffreys. British Conchology, 5 vols. (Vols. 1 and 5.)
Reeve. Land and Fresh-Water Mollusks of Great Britain. London, 1863.
Moquin-Tandon. Hist. Nat. Moll. de France, 1855.
Morelet. Coq. terr. du Kamtschatka. Jour. de Conchyl. 392, 1857.
Mörch. Land and Fresh-Water Mollusks of Greenland and Iceland; American Jour. of Conchology, iv, 1869.
Kreglinger. Deutschlands Binnen-Mollusken. Wiesbaden, 1870.
Westerlund. Fauna Molluscorum Sueciæ, Norvegiæ et Daniæ.
Kobelt. Jahrb. Deutsch. Mal. Gesell., iv, v.

Rossmassler. Iconog. der Land und Susswasser-Mollusken Europas.

II. *Mediterranean Region*:—

Rossmassler and Kobelt (cited above.)

Hidalgo. Moll. Terr. de España y Portugal.

Morelet. Desc. Moll. terr. et fluv. du Portugal, 1845.

Bourguignat. Malacologie de l'Algerie. Mollusques du Sahara. Testacea Novissima. Hist. Malacol. de la Regence de Tunis, 1868.

Stabile. Moll. du Piedmont, Milan, 1864.

Paulucci. Escurzione scient. nella Calabria, 1877–8.

Bielz. Fauna der Mollusken Siebenburgens. Hermannstadt, 1863.

Benoit. Testacea extramarini della Sicilia. Naples, 1857–1862.

Mousson. Coq. terr. et fluv. de Palestine, 1861; Coq. de l'Orient, 1859.

III. *Central Asiatic Region*:—

Martens. Fedtschenko's Reise in Turkestan. Mollusken.

IV. *Chinese Region*:—

Schrenck. Reisen und Forschungen im Amur-Lande. 1859–1867.

Heude. Conch. fluv. de la Chine centrale, etc.

Heude. Notes sur les Mollusques de la Vallée du Fleuve Bleu.

Crosse et Debeaux. Jour. de Conchyl., xi, xii.

V. *Japonic Region*:—

Crosse. Jour. de Conchyl., 386, 1860.

VI. *Atlantic Region*:—

Wollaston. Testacea Atlantica, 1878.

Morelet and Drouet. Mollusques des Açores, 1860.

Albers. Malacographia Maderensis. Berlin, 1854.

VII, VIII. *Central and West African Regions*:—

Morelet. Voy. du Dr. Welwitsch dans les Royaumes d'Angola et de Benguela, 1868.

Morelet. Series Conchyliologiques.

E. A. Smith. Proc. Zoological Society. London, 1877, 1880, 1881.

IX, X. *South African and Malgachian Regions*:—

Krauss. Die Südafrikanischen Mollusken. 1848.

Lienard. Cat. faune malacol. Maurice, Iles Sèchelles, etc.

Deshayes. Conchyliologie de l'Ile de la Réunion. Paris, 1863.

XI. *Afro-Arabic Region*:—

Von Martens. Land und Süsswasser Mollusken des Nil-Gebietes.

Morelet. Voy. Beccari et Issel. Moll. de l'Abyssinie.

XII. *Indian Region*:—

Hanley and Theobald. Conchologia Indica. London, 1876.

XIII, XIV. *Indo-Chinese and Indo-Malaysian Regions*:—
Crosse and Fischer. Jour. de Conchyl., 332, 1864.
Von Martens. Die Preussische Expedition nach Ostasien, 1867.
Mousson. Land und Süsswasser Mollusken von Java. Zurich, 1849.
XV-XVIII. *Philippine, Austro-Malaysian, Australian, and Austro-Polynesian Regions*:—
Semper. Reisen im Archip. der Philippinen. Mollusca.
Cox. Australian Land Shells. Sydney, 1868.
Woods. Proc. Royal Soc. Tasmania.
Gassies. Faune Conch. terr. et fluv. de la Nouvelle Caledonie, 3 parts. Paris, 1863–1880.
XIX. *Polynesian Region*:—
Hartman. Catalogue of the genus Partula. West Chester, Penn'a, 1881.
Mousson. Numerous papers in Jour. de Conchyl. Paris.
Pease and Garrett. Am. Jour. Conch., Proc. Philad. Acad., etc.
Newcomb. Synopsis of Achatinella. Ann. N. Y. Lyceum, vi.
XX. *New Zealand Region*:—
Hutton. Manual of the New Zealand Mollusca, 1880.
XXI-XXV. *Patagonian, Chilian, Peruvian, Columbian and Brazilian Regions*:—
D'Orbigny. Voy. Amer. Merid. Mollusques.
Strobel. Materiali per una Malacostatica dell' Argentina Meridionale.
Wagner (Spix). Test. fluv. Brasil. 1827.
Morelet. Series Conchyliologiques.
Hidalgo. Moluscos del Viage al Pacifico.
Drouet. Mollusques de la Guyane Francaise. Paris, 1859.
XXVI. *Mexican Region*:—
Morelet. Testacea Novissima, 1849–51.
Fischer and Crosse. Mission Scient. au Mex. et à l'Amer. Centr. Mollusques.
Strebel et Pfeffer. Mexikanischer Land und Süsswasser Conchylien.
XXVII. *Caribbean Region*:—
Bland. Am. Jour. Conch., 1866. Geographical Distr. of Land Shells of West Indies. New York, 1861.
Kobelt. Jahrb. der Deutsch. Malak. Gesellsch., 1880.
Adams. Contributions to Conchology, 1849–1852.
Arango. Moluscos terr. y fluv. de la Isla de Cuba.
D'Orbigny. Mollusques de l'Ile de Cuba.
XXVIII, XXIX. *American and Californian Regions*:—
Binney. Land and Fresh-water Shells of North America: 3 parts. Smithsonian Institution, Washington, D. C.
Terrestrial Air-breathing Mollusks of the United States. (Bulletin Mus. Comp. Zool.) Cambridge, Mass., 1878.

Haldeman. Monog. of Fresh-water Univalve Mollusca of the U. S., with Continuation by Tryon.

Tryon. Monograph of Strepomatidæ. Smithsonian Institution, Washington, D. C., 1873.

Prime. Monograph of American Corbiculadæ. Smithsonian Institution, Washington, D. C.

Lea. Observations on the Genus Unio. 13 vols., 4to. Philadelphia.

Cooper. The Origin of Californian Land Shells. Am. Jour. Conch.

Principal Iconographic Works on General Conchology.

Reeve. Conchologia Iconica. 20 vols., 4to. London, 1843–1878. This magnificent work contains over 2600 beautifully colored plates, carefully drawn from nature by Mr. Sowerby. The importation cost of a copy is about one thousand dollars. It has great value as the exponent of the British Museum and Cumingian collections (*ante*, p. 150); but there is no attempt at completeness: only those species are described and figured which were readily accessible to the artist, and even these are presented without arrangement corresponding with their natural alliances. The genera included are all very incomplete: many genera are omitted.

Sowerby, G. B. Thesaurus Conchyliorum, or Figures and Descriptions of Recent Shells. 8vo. London, 1847–1882. 38 parts published, containing 121 genera, illustrated by 444 colored plates, drawn by Mr. Sowerby. Importation cost, about three hundred dollars. The figures are generally reduced in size, so that many of them can be crowded on a plate. The Thesaurus is a much cheaper work than Reeve's Iconica in proportion to the number of species illustrated; but it has the same faults of want of arrangement and incompleteness.

Kiener, L. C. Coquilles Vivantes. 165 parts, 8vo. Paris (no date . The family Trochidæ, left unfinished by Kiener, has recently been completed by Dr. Paul Fischer; all the other monographs were published many years since, when comparatively few species were known. There are about 900 beautifully colored plates. A copy can be imported for about two hundred and twenty-five dollars. Kiener's work is fragmentary only, and the species are frequently wrongly named.

Küster. Systematischen Conchylien Cabinet. 320 parts, 4to. This grand work, in course of publication for nearly fifty years, approaches completion. It contains over 1800 beautifully executed colored plates. The more recent monographs are carefully prepared by such specialists as Kobelt, Weinkauff, Pfeiffer, Philippi, Dunker, Römer, Clessin, Brot and von Martens. Importation cost, about six hundred and fifty dollars.

Tryon. Manual of Conchology; structural and systematic. With illustrations of the species. 4 parts (forming a volume) published annually. Vol. IV completed, 1882. Uncolored $3, colored $5 per part. 8vo. Philadelphia: Academy of Natural Sciences. This is the only monographic and iconographic work in which the genera are taken up in systematic order, and in which the species are arranged in accordance with their inter-relationships.

Conchological Periodicals.

Journal de Conchyliologie. Published by Crosse and Fischer. 30 vols., 8vo. Paris, 1850–1882. Illustrated by colored and plain plates. Subscription price (sent by mail), 18 francs per annum.

Malakozoologische Blätter. 30 vols., 8vo. Cassel, 1854–1882. Price, 10 marks (= $2.50) per volume.

Bulletino della Società Malacologica Italiana. 12 vols., 8vo. Pisa, 1870–1882.

Jahrbücher der Deutschen Malakozoologischen Gesellschaft. 9 vols., 8vo. Frankfurt-am-Main.

Nachrichtsblatt of the same society. 14 vols., 8vo.

Annales et Bulletin de la Société Malacologique de Belgique. 17 vols., 8vo.

Journal of Conchology, London. 3 vols., 8vo, commenced in 1874.

American Journal of Conchology. 7 vols., 8vo. Philadelphia, 1865–1871. Contains 2500 pages, illustrated by 150 plates, many of them colored, besides about one thousand wood-engravings. Price for the set, $42.00.

Systematic Works.

H. and A. Adams. The Genera of Recent Mollusca; arranged according to their Organization. 3 vols., 8vo, with 138 colored plates. London, 1858.

Woodward. Manual of the Mollusca: a treatise on recent and fossil shells. With an Appendix by Ralph Tate. 18mo. London, 1868. 23 plates and numerous wood-engravings.

Fischer. Manual de Conchyliologie: ou Histoire Naturelle des Mollusques vivants et fossiles. 8vo. Paris. To be completed in seven parts, four of which are published. Subscription price for the entire work, 24 francs.

Kobelt. Illustrirtes Conchylienbuch. 4to, with 112 uncolored plates. Nürnberg, 1882.

Bronn and Keferstein. Klassen und Ordnungen der Weichthiere (Malacozoa). 8vo. Leipzig, 1861–1866. The most complete work published upon the anatomy of the mollusca.

Stoliczka. Palæontologia Indica. Vol. II, Gastropoda; Vol. III, Pelecypoda. 2 vols., 4to. Calcutta, 1868–71. Contains the most complete account of the fossil groups.

DISTRIBUTION OF THE MOLLUSCA IN TIME.

The brevity and excellence of the remarks of Dr. Paul Fischer upon the distribution in time of fossil mollusca, is my sufficient apology for transferring them almost bodily to these pages, distinguishing them throughout by quotation-marks: they constitute a most valuable portion of his excellent "Manuel de Conchyliologie."

"Fossils, considered at first," says Fischer, "as *lusus naturæ* or as the remains of animals like those which now people our seas and continents, commenced to be differentiated from living forms towards the close of the last century. Buffon sustained this opinion strenuously: 'The knowledge of all the petrifactions, of which we no longer find living analogues, requires lengthened study, and the thoughtful comparison of all the species of petrifactions which have been found so far in the bowels of the earth, and this science is not yet far advanced; nevertheless we are certain that there are several species such as the Ammonites, the Orthoceratites, the Belemnites, etc., to which no existing species can be referred. * * * Their petrifaction is the great means by which nature has preserved forever the record of perishable beings; it is in fact by these that we recognize the most ancient productions and that we have an idea of these *species now annihilated*, the existence of which has preceded that of all living and growing objects; *they are the sole monuments of the earlier ages of the world; their form is an authentic inscription, which it is easy to read in comparing them with similar organized bodies.* * * * It is above all among shells and fishes, the first inhabitants of the globe, that we can count a very large number of species which no longer subsist; I will not undertake their enumeration here, which, although lengthy, would be still incomplete; such a work upon ancient nature would alone require more time than yet remains to my life, and I can only recommend it to posterity.'

"This passage indicates clearly that Buffon already considered fossils as a means of establishing the chronology of stratified rocks. In the inquiry which he indicated, Cuvier and A. Brongniart in France, and W. Smith in England, almost simultaneously engaged. The two former, in 1808, remarked that the fossils distributed in each bed generally remain the same throughout its extent, but differ in passing from one bed to another. This character serves to distinguish the beds, and to recognize their recurrence at distant localities. 'This is a mark of recognition,' they say, 'which so far has never failed us.'

"A. Brongniart is still more explicit in 1822: 'In order to characterize the strata, one must not only designate the species found in them, but designate them all, determine them very

exactly, so as not to give the same name to bodies which, having apparent resemblances, are nevertheless distinct species, although closely related. Such is the important connection of zoology with geology. It is by this double consideration that we shall attain the aim of the latter science, which is the exact knowledge of the relative antiquity of the beds which form the shell of the globe.'

"The views of William Smith are not less pointed: 'Organized fossils are to the naturalist as coins to the antiquary; they are the antiquities of the earth; and very distinctly show its gradual, regular formation, with the various changes of inhabitants in the watery element.'

"Whilst modern geologists recognize all the great principles established by Buffon, Cuvier, Brongniart and Smith, they vary in the interpretation of the laws of succession of living beings upon the surface of the earth.

"One school, which has had for its chiefs A. d'Orbigny and Louis Agassiz, and which has perhaps borrowed from Cuvier the basis of the doctrine, admits that living nature has been renewed a great number of times, without the beings of one period being able to perpetuate their specific existence into the succeeding period. Consequently each period preserves for us the remains of a special creation, terminated by a general cataclysm. Such is the theory of successive creations, which has ruled during about a quarter-century and which has given a remarkable impulse to palæontology.

"In the opposing school, to which are attached the names of Brocchi, Constant Prevost, Boué, Lyell, d'Archiac, Gaudry, Tournouër, and which, in certain points of view, approaches the theories of Lamarck, of Geoffroy Saint-Hilaire and of Darwin, great cataclysms no longer exist as the general cause of the destruction of life; their influence is purely local; life has never been interrupted, although modified during the series of ages.

"In the appreciation of the fossils these two schools arrive at nearly identical conclusions. For the school of multiple creations, the fossil serves to characterize a period; for the developmental school, the fossil, by its more or less advanced state of evolution, takes the place of a chronometer for judging the antiquity of the beds where it has been discovered. Whatever may be the theory, it is admitted then as demonstrated, that each period of life on the surface of the earth has been characterized by living beings, the ensemble of which has differed from that of the preceding and subsequent periods. Each fossiliferous bed of importance may practically be considered as representing a distinct creation; consequently each period has its peculiar fossils."

A circumstance which gives to fossils a great importance as

characteristic of beds, is that their occurrence is never repeated. They become extinct or modified. "One of the proofs that species are extinct consists in the fact that they have been replaced by other species having filled the same functions and found in deposits formed under similar conditions" (Forbes).

"These ideas have been combatted by the advocates of the doctrine of colonies, who admit the reappearance of species after the lapse of a period more or less long, and at different levels. But folds, dislocations and faults may simulate the reappearance of an identical fauna. In this case, colonies would be, as d'Archiac has written, only stratigraphical illusions, resulting from an incomplete appreciation of facts, judged by deceptive appearances. 'From the moment when a type has appeared for the first time, to the moment when it has entirely disappeared, there has never been an interruption in its existence'" (Pictet).

The very ancient and nearly extinct order of tetrabranchiate cephalopods has been the subject of much discussion between the creative and development schools of naturalists, and may be conveniently adduced for the purpose of exhibiting their respective lines of argument. This work would be enlarged to undue proportions were I to attempt to discuss the subject at length: a few pages extracted from Vol. I of my "Manual of Conchology" will give an idea of it:

Mr. Alpheus Hyatt has remarked that the young of all the coiled cephalopods start with a straight or bent cone, and begin their coil abruptly, always leaving an opening in the umbilicus through the centre of the first whorl. The development of the Nautiloids, in time, is also marked by a gradual involution from the perfectly straight Orthoceras to the *Nautilus Pompilius*, where the expansion of the last whorl conceals the umbilicus. The progress of the Ammonoids, on the other hand, is marked by the gradual uncoiling of the shell, ending with the straight Baculites of the cretaceous; this feature is, therefore, of great importance in a natural classification of these groups.*

Mr. Hyatt has also carefully studied the embryology of the shell of the fossil cephalopoda; and in a richly illustrated memoir, published by the Museum of Comparative Zoology, at Cambridge, Mass., he attempts to prove the development theory by the results of these studies.

M. Joachim Barrande, however, who is the most distinguished of living authorities upon the fossil cephalopods, differs in toto from Mr. Hyatt's decisions. He has published (in 1877) "Etudes Générales," in which he devotes over two hundred octavo pages to a careful review of the entire subject, and reaches the following conclusions:

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* *Proc. Bost. Soc. N. H.*, xii, 216, 1868.

I. *Generic Types.*

1. Absence of cephalopods in the primordial silurian fauna of all the countries where it has been ascertained to exist; that is to say in about 25 natural basins, largely spread over the two continents. This absence is in harmony with that of the acephala and the rarity of gasteropoda and heteropoda in the same fauna. It is inexplicable by the theories of evolution.
2. Sudden appearance of 12 types of cephalopods in the first aspect of the second Silurian fauna.

   This sudden appearance is as inexplicable as their total absence in the primordial fauna. This number, 12, constitutes nearly half of the 26 types admitted in his studies, among the 3 families: Nautilidæ, Ascoceratidæ and Goniatidæ.
3. The 12 primitive types show, in their earliest species, the contrast and plenitude of their characters.

   This plenitude and this contrast are above all remarkable in two straight types: Orthoceras and Bathmoçeras. One sees also in some species the maximum of the size known, as in *Naut. ferox* Bill. of Canada. The plenitude of typical characters and the size not surpassed by later appearing species, are in disaccordance with the slow and successive progress attributed to evolution.
4. The 12 primitive types are very unequally distributed in the palæozoic countries. This distribution indicates no centre of diffusion, no point of departure for evolution.
5. Among the 12 primitive types, are found those the most contrasted in form and structure. Ex.:

   Orthoceras, with straight shell.
   Cyrtoceras, with curved shell.
   Nautilus, completely spiral in the same plane.
   Trochoceras, doubly spiral.
   Bathmoceras, shell straight, but characterized by an obsolete siphon.

   In order to derive from a common ancestor types so much differentiated, one must have an indefinite number of generations and of transition-forms, of which there remain no trace whatever.
6. The 14 types posterior to the 12 primitive types, also appeared as suddenly, without being announced by any transition-form, as for example: Ascoceras and Goniatites. One can apply to them also the preceding observation.
7. The vertical position of the 26 types in respect to their first appearance, offers a combination the most opposed to evolution, for instead of showing a successive progress in the number of first appearances, it presents a rapid diminution thereof. In fact:

16 of these 26 first appearances (comprising the 12 primitive types) are found within the limits of the 2d fauna.
8 in the limits of the 3d fauna.
1 towards the end of the Devonian fauna.
1 during the Eocene period.

8. This diminution of the apparitions of generic types is in disaccordance with the increase of the number of species during the Silurian period.

   In effect, if the new types were formed by the divergence of the species, as supposed by the development theory, the increase of the number of specific forms must entail an increase of the number of generic types. In any case it could not cause a diminution of them.

   Then, each of the principal facts that we have given on the subject of generic types, constitutes a grave discordance between the theories of evolution and the reality.

II. *Specific Forms.*

1. We have never acquired the certainty and we have never been induced to suppose that any species among the cephalopods of Bohemia was derived by filiation and transformation from another anterior species. The filiation and transformation are then, in our point of view simply theoretic fictions.
2. No species, to our knowledge, has been transformed to a new generic type, neither by successive slow variations nor by sudden changes.

   On the contrary we have ascertained at various times that all the species and all the groups of the congeneric forms, which have varied sensibly from their generic type in certain particulars and which appeared to tend towards a new type, appeared and disappeared suddenly, without leaving any posterity preserving the traces of the same character.
3. Our second phase of Fauna No. 3 possesses alone 777 species of cephalopods, that is to say about 31 per cent. of all the species of this order known in the Silurian. Our basin, very remarkable for its small size furnishes about 45 per cent. of these.

   These accumulations of cephalopods in surfaces so restricted are in contradiction with the theories of natural selection and of the struggle for existence.

III. *Elements of the Shell.*

The particular study of each of the elements of the shell of the cephalopods, of which we have presented a resumé, shows that none of them have followed a gradual variation in any one direction. On the contrary, we have observed the stability of

these elements, notwithstanding their specific and temporary variations. These facts are manifested above all in the genera of which the duration has been the longest, as Orthoceras and Nautilus.

IV. *Stability of the Genera.*

1. Orthoceras takes the second rank, by its longevity, among the generic types, but the first by its richness in species, since it furnished alone about half those of the Palæozoic cephalopods. It traverses every age, commencing with the origin of the second fauna, to the extinction of the Triassic fauna. Its species, very diverse in every horizon, preserve nevertheless their typical features very plainly, in about 1146 forms enumerated in our studies.

   Among the proofs of the stability of the elements of the shell in this genus, we have observed a very remarkable and probably unique fact in palæontology. It is that on Plate 1, of Dr. V. Mojsisovics' "Das Gebirge um Hallstatt," is shown seven species of Triassic Orthoceras, which could be intercalated among the plates representing the Silurian species of our fauna No. 3, without any man of science supposing that he saw the last remains of that type. In fact, they are hardly distinct from the species which characterized the epoch of the most luxuriant vitality of the genus.

2. Nautilus has enjoyed the privilege of an incomparable duration, from the first appearance of cephalopods, at the origin of the second Silurian fauna to the present time. The succession of its species has traversed every geological age, and if it had been subjected to the supposed influences of evolution, it would show us a series of transformations or of progressions which, accumulating, would far remove the present from the primitive forms. We do not see why these extreme forms arising during the existence of Nautilus should not contrast among themselves like those of the Amphioxus and of *Homo sapiens*, between which imaginary evolution has worked, according to theory, in nearly the same period of time.

   But the material facts discovered by palæontology and accessible to every one, dispel all illusion. In effect, the Nautilides, notwithstanding the great number of their specific forms, which must exceed 300, depart so little from their initial type, throughout the geological ages, that the merest novice would not hesitate in any case to recognize their generic nature. The variations or differences among the species, oscillate without any tendency to continue in a single direction so as to found a new type. In the actual fauna, Nautilus does not show, between its forms and the primitive forms, any greater differences than those which all naturalists

agree in considering as purely specific. Even the Triassic Nautilides show less affinity to existing species than do the primitive forms. The theoretical evolution of the cephalopods, like that of the Trilobites, appears to us to be imaginary, without any foundation in fact.*

Dr. Paul Fischer, in a notice of Barrande's work, whilst acknowledging the strength of the facts and observations brought forward by that distinguished palæontologist against the development theory, does not consider them conclusive: The type Goniatites, says M. Fischer, has always been considered by evolutionists as a natural transition between the Nautilus with its very simple partitions and the foliaceous sutures of the Ammonite; an opinion which is strengthened by the appearance of Goniatites chronologically intermediate between the other two. In order to show the extreme difference which exists between the Nautilus and the Goniatites, M. Barrande has studied the characters of the initial shell in these two genera—a study which has acquired great importance since the publication of Mr. Alpheus Hyatt's "Fossil Cephalopoda."

Mr. Hyatt has shown that the initial chamber of *Nautilus Pompilius* shows an elongated nearly linear cicatrice, enclosed by an elliptical surface slightly depressed. He supposes that the ovisack was attached to the elliptic surface, and that the cicatrice is the vestige of an opening which placed this ovisack in communication with the initial air-chamber of the shell; but he has never seen this supposed ovisack, which is hypothetical. For him, the Nautilus is a cephalopod which has lost its ovisack.

In Ammonites and Goniatites the initial disposition is entirely different. The ovisack is plainly visible, globular or ellipsoidal, more dilated than the part contiguous to the chambered spire. No appearance of a cicatrice. It suffices, consequently, to examine the first chamber of a cephalopod to class it among the Nautilides or the Ammonides and Goniatides.

M. Barrande has shown that the initial appearance of the shell of Nautilus is exhibited without any change through all the geological periods to the present time. The fissure is supposed by M. Barrande to have placed the mollusk contained in the initial chamber in communication with a transitory organ, either a vitelline vesicle (which, to M. Fischer, appears inadmissible) or to a natatory bladder, etc.

From the first appearance to the final extinction of the Goniatidæ and Ammonitidæ, they always show a typical ovisack; it is therefore impossible to derive them from the Nautilidæ, as supposed by some developmentalists. This difference has induced M. Munier-Chalmas (*Comptes Rendus*, Dec. 29th, 1873) to

* "Céphalopodes, Etudes Générales," 224–230, 1877.

separate the two former from the tetrabranchiate or tentaculiferous Cephalopoda (Nautilidæ), and to unite them with the dibranchiate or acetabuliferous group (Spirulidæ and Belemnitidæ), which are provided with an ovisack.

It still remains to ascertain whether the presence or absence of the ovisack has the systematic importance attributed to it; what is its nature and what is the purpose of the cicatrice. The word ovisack may be badly chosen because it supposes the existence of calcareous envelopes to the eggs.

One might discuss and wonder a long time on this subject until a direct observation on the embryogeny of Nautilus shall give us the true solution. It is thus that the question of the parasitism of the Poulpe of the Argonaut was agitated with ardor until the day that Duvernoy showed the embryo of Argonaut to be provided with a shell in the egg.

M. Fischer concludes, "Is the doctrine of evolution overthrown by the facts M. Barrande has produced? I do not think it. He has proved that there existed among the ancient cephalopods two great types, which have continued separate during the entire period of their existence; but the evolution of each of these types remains extremely probable, and conforms to observations made upon them. In such matters one cannot, in effect, ask more than a probability." *

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* *Jour. de Zool.*, iv, 419, 1877.

TABLE OF SEDIMENTARY DEPOSITS.

The comparative vertical thickness of the several Periods is not herein represented.

AMERICAN.			EUROPEAN, ETC.	
Beds, Synonyms.	*Epochs.*	*Periods.*	*Epochs.*	*Beds, Synonyms.*
	Recent.	Quarternary.	Recent.	Iron age. Bronze age. Neolithic era. Reindeer era.
Champlain. Glacial (Drift).	Post-Pliocene. (Pleistocene.)	Quarternary.	Post-Pliocene. (Pleistocene.)	Post-glacial. (Loess, cave-deposits, mammoth period, paleolithic era.) Glacial. Pre-glacial.
Sumter Period (Eastern U. S.). Loup Fork (Western U. S.).	Pliocene.	Tertiary.	Pliocene.	Newer Pliocene.—Norwich Crag, Chillesford beds, Upper Val d'Arno, Sicilian. Older Pliocene.—White or Coralline Crag, Red Crag, Antwerp Crag, Sub-Apennine, Val d'Arno, Aralo-Caspian, Congerian and Belvedere stages of the Vienna Basin. Sivalik ?

Oregon beds. White River.	Yorktown Period.			(Sarmatian and Mediterranean stages of the Vienna Basin.)	part), Œningian, Tortonian? Sivalik? Lower Miocene.—Molasse (in part), Helvetian, Falunian, Bovey-Tracey.
Vicksburg (Orbitoid limestone).		Oligocene.	Tertiary.	Oligocene. (Nummulitic in part.)	Upper O.—Aquitanian. Middle O.—Tongrian, Hempstead, Bembridge, Fontainebleau sandstone, Mayence Basin. Lower O.—Ligurian, Headon, Montmartre gypsum.
Western U. S. Uinta. Bridger.	*Eastern U. S.* Jacksonian. Claibornian.	Eocene.		Eocene.	Upper E.—Parisian (Calcaire grossier), Bartonian, Lackenian, Bruxellian, Nummulitic (in part) Flysch?
Green River.	Buhrstone. (Siliceous Claiborne.)				Middle E.—Londonian, Suessonian (in part), Ypresian.
Wasatch.	Eo-lignitic.				Lower E.—Oldhaven, Woolwich, Reading and Thanet series, Suessonian (in part), Argile plastique, Landenian. Heersian.

American.				European, etc.	
Beds, Synonyms.		*Epochs.*	*Periods.*	*Epochs.*	*Beds, Synonyms.*
Western U. S. Laramie or Great Lignite. Fort Union. Judith River.		Laramie or Post-Cretaceous.	Laramie.		Mæstrichtian (Danian), Faxö chalk, Calcaire pisolitique.
Western U. S.	*Eastern U. S.*		Cretaceous.		
Fox Hills Group.	Ripley.	Cretaceous. (Green sand of New Jersey.)		Cretaceous.	Senonian (White Chalk).
Colorado Group. Ft. Pierre.	Rotten Limestone.			(Upper.)	Turonian (Chalk marl and chloritic marl), Hippuritic limestone.
Colorado Group. Niobrara.					
Colorado Group. Ft. Benton				(Middle.)	Cenomanian (Upper Greensand). Gault.—Albian, Aptian, Urgonian.
Dakota Group.	Eutaw.			(Lower.)	Neocomian (Lower Greensand), Upper Neocomian of d'Orbigny Wealden.—Weald Clay, Hastings Sands, Panfield series, L. Neocomian of d'Orbigny.

Western U. S. Camarasaurus, Atlantosaurus and Sauranodon beds of Cope and Marsh.	Oolite.	Jurassic.	Oolite.	Upper O.—Purbeckian, Portlandian, Kimmeridgian. Solenhofen states. Middle O.—Corallian. Oxfordian, Argovian. Callovian. Lower O.—Bathonian (Cornbrash, forest marble, Great Oolite). Bajocian (Fuller's earth, Inferior Oolite).
			Lias.	Upper L.—Toarcian. Middle L.—Liasian. Lower L.—Sinemurian.
Triassic deposits of the Atlantic border and those of the Western interior—both probably Jurassic in part (Connecticut red sandstone, etc.).		Triassic.	Rhætic. Keuper. Muschelkalk. Bunter-sandstein.	Penarth beds, Dachstein. Saliferian, St. Cassian, Hallstadt. " Conchylien." Variegated sandstone, " Grès bigarré."

American. Beds, Synonyms.		American. Epochs.	Periods.	European, etc. Epochs.	European, etc. Beds, Synonyms.
Strata of the interior Continental Basin—Texas.			Permian.	Zechstein.	Magnesian limestone, Kupferschiefer.
				Rothliegende.	"Rothtodtliegende."
(Subcarboniferous.) Chester, St. Louis, Keokuk, Burlington & Kinderhook groups.		Coal Measures. Millstone grit. Mountain limestone.	Carboniferous.	Coal Measures. Millstone grit. Mountain limestone.	(Subcarboniferous.)
Catskill.		Upper D.—	Devonian (Old Red Sandstone).	Upper D.—	Pilton group, Clymenian.
Chemung.	Chemung. Portage.				
Hamilton.	Genesee. Hamilton. Marcellus.			Middle D.—	Ilfracombe group, Eifelian.
Corniferous.	Corniferous limestone (Upper Helderberg). Schoharie.	Lower D.—		Lower D.—	Lynton group, Spiriferian,

Oriskany. Lower Helderberg. Salina (Onondaga). Niagara (Clinton and Medina).	Upper Sil.—	Silurian.	Upper Sil.—	(3d fauna of Barrande—Étages E, F, G and H.) Ludovian. Wenlockian. May Hill.
Cincinnati. { Hudson River. Utica slates. Trenton. { Trenton limestone. Black River " Bird's eye " Quebec. { Chazy limestone. Quebec shales. Calciferous.	Lower Sil.—		Lower Sil.—	(2d fauna of Barrande—Étage D.) Llandoverian. Caradocian (Bala). Llandeilian. Arenig.
Potsdam sandstone. Acadian.	Cambrian.	Cambrian.	Upper C.—	(Primordial fauna of Barrande—Étage C. Tremadocian.
			Lower C.—	Lingulian. Menevian. Harlech and Longmynd.
		Huronian.		

AMERICAN.			EUROPEAN, ETC.	
Beds, Synonyms.	*Epochs.*	*Periods.*	*Epochs.*	*Beds, Synonyms.*
Norian, or U. Laurentian. Middle Laurentian. Bojan, or L. Laurentian.		Laurentian.		Fundamental gneiss, "Urgneiss," Bojangneiss, Hercynian gneiss.

Note.—The Laurentian and Huronian are collectively termed Archæan or Eozoic.

The Cambrian to Permian inclusive = Palæozoic (old "primary").

The Triassic to Cretaceous inclusive = Mesozoic (old "secondary").

The Laramie is classed by some as Mesozoic, by others as Kainozoic.

The Tertiary and Quaternary = Kainozoic or Neozoic.

For the above table of fossiliferous strata, prepared especially for this work, I am much indebted to Prof. Angelo Heilprin, who has been at considerable pains to correlate the American and European beds as nearly as possible, as well as to include all the names usually met with in geology and palæontology.

Fossil Mollusks of the Palæozoic Period.

"The study of the earliest manifestations of life upon the surface of the globe will always have great attraction for naturalists. In 1868, Bigsby prepared the following table of the primordial or Cambrian fauna, which includes 972 species.

Plantæ,	22	Asteridea,	1	Brachiopoda,	116
Amorphozoa,	27	Annelida,	29	Lamellibranchiata,	12
Cœlenterata,	6	Trilobita,	417	Pteropoda,	57
Crinoidea,	1	Entomostraca,	25	Gastropoda,	115
Cystidea,	2	Polyzoa,	77	Cephalopoda,	65

"Consequently, from the beginning the principal types of mollusca are represented; the gastropods are as well developed as the brachiopods, and the cephalopods surpass in number the pteropods, which are, nevertheless, inferior in organization. In the middle and upper beds of the Silurian, the brachiopods make an enormous increase; the cephalopods arrive at their apogee; then come, according to their importance, the gastropods, the lamellibranchs, and finally the heteropods and pteropods.

"In the Devonian and Carboniferous periods, the brachiopods sensibly diminish, and lose the first place, which is occupied by the lamellibranchs; the gastropods become more numerous than the cephalopods.

	Silurian.	Devonian.	Carbonif.	Total.
Brachiopods, species,	1650	695	875	3220
Lamellibranchs, species,	709	927	1214	2850
Gastropods, species,	895	621	674	2190
Pteropods and Heteropods, species,	338	138	108	604
Cephalopods, species,	1454	558	410	2424

"Consequently, in palæozoic periods the classes of Malacozoa occupy the following order according to the number of their species: 1, Brachiopods; 2, Lamellibranchiates; 3, Cephalopods; 4, Gastropods; 5, Pteropods and Heteropods.

"We can then characterize the palæozoic epoch as the age of brachiopods.

"We have no table of mollusks of the Permian, but it is scarcely probable that the fossils of this formation would modify the preceding conclusions.

"The Nautilidæ, among the cephalopods, shone with all their lustre during the Silurian; it is then that their genera presented the most varied forms. Orthoceras was multiplied to a degree unheard of, since in the single basin of Bohemia, Barrande has been able to distinguish 554 species.

"There lived in the Silurian seas at the same time some pelagic mollusks (pteropods and heteropods), belonging to the genera Bellerophon, Conularia, Maclurea. The gastropods were nearly all holostomate: Acroculia, Euomphalus, Loxonema, Murchisonia, Pleurotomaria, Platyostoma. The principal lamellibran-

chiates were Ambonychia, Pterinea, Avicula, Cardiola, Conocardium, Ctenodonta, Grammysia, Orthonota, Tellinomya, etc.

"The Devonian genera differ but little from those of the Silurian, but we must mention, among the cephalopods, Bactrites, Clymenia, Goniatites, Gyroceras; among the heteropods, Porcellia; among the gastropods, Scoliostoma, Loxonema, Turbo, Euomphalus, etc.; among the lamellibranchiates, Megalodon, Schizodus, Solenopsis, Aviculopecten, Stenopistha, etc.

"The Carboniferous is richer in species than the Devonian. The cephalopods are Goniatites, Nautilus of particular types, Orthoceras; the most common gastropods belonged to the genera Chiton, Euomphalus, Loxonema, Macrocheilus, Murchisonia, Pleurotomaria, Turbo; the pteropods and heteropods are generically similar to those of the Devonian; among the lamellibranchiates we cite the genera Aviculopecten, Allorisma, Solenomya, Astartella, Anthracosia, Cardiomorpha, Ctenodonta, Edmondia, Myalina, Schizodus, etc.

"The Permian fauna, very poor in mollusks, contains few generic types which are wanting to the Carboniferous. The important genera are: Nautilus, among the cephalopods; Chiton, Rissoa, Turbo, Natica, Macrocheilus, Pleurotomaria, Euomphalus, among the gastropods; Pecten, Lima, Monotis, Mytilus, Edmondia, Cardiomorpha, Bakewellia, Byssoarca, Pleurophorus, Schizodus, Astarte, Allorisma, Solemya, Eumicrotis, Myalina, among the lamellibranchs.

"Nevertheless this geological period presents to us a very important feature, the appearance of Ammonites properly so-called, represented by several species of Sageceras and Arcestes, which become important in the Trias. At the same time, the Goniatites became extinguished or transformed into Ammonites, which extend through the entire series of secondary rocks.

"A certain number of living genera have been indicated as palæozoic:

"Brachiopods.—Discina, Lingula, Rhynchonella, Terebratula.

"Lamellibranchs.—Avicula, Anomia, Pinna, Lima, Pecten, Ostrea, Plicatula, Amphidesma, Anatina, Anodonta, Arca, Astarte, Axinus, Cardium, Corbis, Crenella, Cucullæa, Donax, Dreissensia, Isocardia, Lithodomus, Lucina, Lutraria, Mactra, Lyonsia, Panopæa, Pandora, Pholadomya, Pullastra, Solemya, Solen, Yoldia, Teredo, Unio, Venerupis, Venus.

"Gastropods.—Aclis, Chiton, Eulima, Elenchus, Emarginula, Lacuna, Fusus, Helcion, Littorina, Natica, Narica, Paludina, Pyrula, Scalaria, Trochus, Turbo, Siphonaria, Tornatella, Turritella, Calyptræa, Capulus, Phasianella, Vermetus.

"Pteropods.—Cleodora.

"Cephalopods.—Nautilus, Spirula.

"But many palæontologists consider these identifications

erroneous, believing that the palæozoic forms, have only a superficial resemblance to living forms in their testaceous envelope. They can well suppose that animals essentially different were able to live in shells of the same form, since in our days we see analogous facts. For examples, may be cited the genera Carelia, Glandina, Halia, Ferussacia, which were considered as Achatina, until their anatomy became known."*

Fossil Mollusks of Mesozoic time. "During the three principal formations of the mesozoic period (Triassic, Jurassic, Cretaceous), cephalopods of the family Ammonitidæ took an extraordinary development, and although the number of species was inferior to that of the lamellibranchs, or even of the gastropods, they nevertheless characterize the most of the stratified beds. Individually, they were as abundant relatively as were the brachiopods of palæozoic seas.

"The following table is prepared from the numbers furnished by Bronn in 1855.

	Triassic.	Jurassic.	Cretaceous	Total.
Brachiopods, species,	34	120	217	371
Lamellibranchs, "	245	1043	1590	2878
Gastropods, "	393	497	446	1336
Cephalopods, "	106	547	509	1162

"According to the number of their species the mesozoic Malacozoa may be thus classed: 1, Lamellibranchs; 2, Gastropods; 3, Cephalopods; 4, Brachiopods; 5, Pteropods and Heteropods—scarcely any. The mesozoic epoch may consequently be justly styled that of lamellibranchs. The predominance of this class of mollusks is nearly constant.

"If we follow in a determined geographical region, the regular succession of the beds, we will generally find the same relative proportions of the various mollusks. Thus the Liassic deposits of the basin of the Rhone, studied by Dumortier, give us these results:

*I do not think that Fischer could have selected more unfortunate examples in illustration of this argument. These genera are all readily distinguishable by the shell alone, and Halia was known to be a marine shell long before we knew anything of the animal. To adduce the errors of naturalists, which have arisen solely from carelessness in not noticing manifest characters as a proof that these characters cannot be depended on in fossil genera, when they are the *only* characters by which we shall ever be able to distinguish them is to change natural history from a science of observation to a speculative science. Fischer could scarcely have stated more plainly the developmentalist position, than he has done in the above paragraph, the meaning of which is: Since development is true, these ancient appearances of so many modern genera must be deceptive, however plausible. For myself, I prefer fact to theory, and until I can distinguish different generic characters in a palæozoic Pholadomya, I shall not doubt that it *is* a Pholadomya.

	Infra Lias	Lower Lias.	Middle Lias.	Upper Lias.	Total.
Brachiopods,	2	18	44	20	**84**
Lamellibranchs,	111	78	115	82	**386**
Gastropods,	74	36	78	66	**254**
Cephalopods,	9	63	65	111	**248**

"It is only in the Upper Lias that the cephalopods surpass the lamellibranchs.

"The type Nautilus, so rich and varied during palæozoic times, declines more and more through the Mesozoic beds. The last of the Orthoceras became finally extinguished in the Trias. In the Lias appeared Belemnites, which was perpetuated to the end of the Cretaceous period, and the abundance of which in those seas is as remarkable as that of Orthoceras in palæozoic seas. "The Trias is characterized by a great number of the subdivisions of Ammonites. Thus, we are acquainted, in this formation, with 130 species of Arcestes, and with numerous Didymites, Lobites, Tropites, Clydonites, Ceratites, Trachyceras, Pinacoceras, Sageceras. Among the uncoiled Ammonites may be cited Cochloceras and Rhabdoceras. The gastropods are very numerous; the limited fauna having been studied with care at Saint-Cassian; they are: Chemnitzia, Loxonema, Rissoa, Eulima, Trochus, Turbo, Pleurotomaria, Cerithium, Helcion, etc. The lamellibranchs belonged to the genera Myophoria, Cardium, Leda, Nucula, Arca, Myoconcha, Mytilus, Avicula, Posidonomya, Pecten, Ostrea, Dicerocardium, Halobia, etc.

"The Jurassic contains some peculiar types of Ammonites: Arietites, Ægoceras, Harpoceras, Oppelia, Stephanoceras, Peltoceras, etc.; some Ammonites with uncoiled whorls: Toxoceras, Ancyloceras; numerous species of Belemnites, and several other cephalopods approaching the Calamaries: Palæoteuthis, Leptoteuthis, Acanthoteuthis, etc. The characteristic gastropods belonged to the genera Bourguetia (Phasianella), Pleurotomaria, Trochotoma, Pileolus, Rimula, Straparollus, Chemnitzia, Eucyclus, Nerinæa, Alaria, Spinigera, Purpuroidea, Cylindrites, Acteonina. We cite among the lamellibranchs, the genera Panopæa, Pholadomya, Astarte, Opis, Hippopodium, Ceromya, Cardinia, Trigonia, Unicardium, Lima, Pecten, Ostrea, Gryphæa, Gervillia, Pernostrea, Plicatula, Sowerbya, Cyprina, Isocardia, Pinnigera, Diceras, Hypotrema, etc.

"In the Cretaceous appeared the sections of Ammonites for which have been proposed the genera Sphenodiscus, Schloenbachia, Hoplites, Acanthoceras, Stoliczkaia; Ammonites with uncoiled whorls became very numerous: Crioceras, Ancyloceras, Baculites, Baculina, Ptychoceras, Hamulina, Scaphites, Toxoceras, Heteroceras, Helicoceras, Turrilites. The exaggerated mutations of this type announce its near extinction. The Belemnites in the lower Cretaceous take forms not less unusual (*B. polygonalis*, *Emerici*, *dilatatus*); the genus Belemnitella

appears in the Cenomanian, and its existence is short. The cretaceous gastropods are relatively rare and belong to the genera Scalaria, Turritella, Chemnitzia, Nerinæa, Avellana, Globiconcha, Varigera, Pterodonta, Natica, Trochus, Turbo, Pleurotomaria, Chenopus, Anchura, Voluta, Fusus, Mitra, Columbellina, Pleurotoma, Pyrula; consequently the Siphonostomata commenced to develop.* The lamellibranchiates approached closely to living types; but several forms are lost; Inoceramus, Myoconcha, Isoarca, Opis, Thetis, and the entire series of the Rudistes (Caprina, Caprinella, Caprotina, Radiolites, Hippurites), which expired with the chalk, and the different horizons of which are so important to geologists.

Neozoic Fossil Mollusks. "Tertiary fossils nearly all belong to living types. The Ammonites, Belemnites, Nerinæas, and Rudistes have become extinct.

"In 1855, Bronn knew more than 8000 species of tertiary mollusks, thus distributed:—

Brachiopods, . . .	52	Heteropods, Pteropods,	25
Lamellibranchs, .	2445	Cephalopods, ...	37
Gastropods, . .	5310		

"The gastropods are dominant, then come the lamellibranchs. The cephalopods are completely in decadence and numerically inferior to the brachiopods. Consequently, the tertiary period was the period of gastropods, a domination which continues to the present time.

"In fact, if we compare the tertiary fauna of the Paris basin with the living fauna of the French coast we find the following confirmatory figures:—

	Basin of Paris (Deshayes).	Coast of France (Fischer).
Brachiopods, sp., ...	15	8
Lamellibranchs, sp., ...	1026	176
Gastropods, sp., ...	1836	364
Cephalopods, sp., ...	14	21

"The relative importance of the types of Malacozoa in the three great periods may be thus represented:—

	Palæozoic.	Mesozoic.	Neozoic.
Brachiopods, ...	1	4	3
Lamellibranchs, ...	2	1	2
Gastropods, ...	4	2	1
Cephalopods, ...	3	3	4

"Thus the brachiopods and cephalopods are to-day plainly in

* Dillwyn has observed that the shells of carnivorous gastropods were almost or entirely wanting in the palæozoic and secondary strata; but they were then replaced, in the economy of nature, by the now almost extinct order of tetrabranchiate cephalopods—of which several thousand species have been described.

decadence; the gastropods progressing, the lamellibranchs stationary.

"The peculiarly tertiary genera are pretty numerous. Among the cephalopods we cite: Spirulirostra, Scaptorrhynchus, Beloptera, Belosepia, Vasseuria, Aturia; among the gastropods: Bifrontia, Borsonia, Cordieria, Volvaria, Deshayesia, Diastoma, Proto, Velainella, Pereiræa, Lesperonia, Velates, etc.; among the lamellibranchs: Teredina, Anisodonta, Psathura, Grateloupia, Lutetia, Pleurodesma, Pecchiola, Carolia, Tindaria, etc.

"It is needless to add that the proportion of these lost genera diminishes as we ascend the series of stratified rocks, and that the number of modern types in the same degree increases.

"It is in accordance with this law, that Deshayes has been able to attempt a first classification of tertiary beds. He called Inferior Tertiary, those which contain but 2 per cent. of living species; Middle Tertiary, those which contain about 18 per cent. of them; and Superior or Upper Tertiary, those having a proportion of about 50 per cent. Lyell created the new names: eocene, miocene and pliocene for the divisions of Deshayes. More recently stratigraphy has permitted a rigorous establishment of their reciprocal relations, and the confirmation of the purely palæontological classification proposed by Deshayes.

Terrestrial and Fluviatile Fossil Mollusks. "The distribution in time of these mollusks is very interesting. They are wanting or extremely rare in the ancient beds and do not assume any importance before the tertiary period. According to Bronn, the principal changes in the exterior conditions of existence, consisted in the progressive development of the terrestrial surface, in the subdivision of the primordial universal ocean into the Mediterranean and Caspian Seas, in the elevation of plateaus and of mountain chains. A corresponding change was manifested in the organic world. With the first exclusively pelagic and swimming population, became associated a marine population, a littoral and finally a terrestrial one.

"The first terrestrial mollusks have been discovered in the Carboniferous and singularly resemble living forms. Authors have described a great number of Carboniferous terrestrial and fluviatile shells, but it appears that the supposed Unios are Anthracosia; the Tichogonia, Avicula; the (European) Planorbis, Serpula, etc. In America, however, we have undoubted terrestrial genera in the Carboniferous: Pupa, Strophites (allied to Strophia), Zonites, Dawsonella.

"In the continental (European) Jurassic formations are cited several Cyrena, Neritina, Planorbis, Melania, Hydrobia. The fauna of the superior lacustrine beds of the Jurassic (Purbeckian) and of the lower Cretaceous (Wealdian) is relatively rather rich. The principal genera are Cyrena, Unio, Melania, Valvata, Hydrobia, Neritina, Planorbis, Physa, Limnæa, Auri-

cula, Carychium. In the lower chalk of Europe many forms have been discovered which resemble living American types: Pleurocera, Lioplax, Goniobasis; in the middle and upper chalk, Cyrena, Melanopsis, Paludomus, Paludina, Melania, Glandina, Bulimus, Physa, Cyclotus, Cyclophorus (?), and Leptopoma (?) abound, mixed with extinct genera: Dejanira, Anastomopsis, Lychnus. The genera of the chalk period which still exist have in great part a quite different modern distribution.

"In the eocene of France, have been discovered Amphidromus, Glandina, Cylindrella, Columna, Megaspira, Cyclophorus, Craspedopoma, associated with Melanopsis, Melania, Pirena, gigantic Physas, Cyrena, Unio, etc. The miocene and pliocene are characterized by numerous species of Helix, Pupa, Glandina, Cyclostoma, Megalomastoma, Strophostoma, colossal Clausiliæ, Testacella, Parmacella, Valenciennesia, Pyrgula, Fossarulus, Lithoglyphus, Paludina, Unio, Dreissensia, Dreissenomya, etc. The abundance of species and their variability was remarkable during the deposit of the Paludina-beds."

In America numerous land and fresh-water shells are found in the strata ranging from the Cretaceous to Eocene, which can not only be referred positively to existing genera, but even to smaller groups now existing; for instance, there are 5 groups of Helix, Planorbis 3 gr., Limnæa 3, Physa 2, Pupa 2, Succinea and Unio.

We cannot better conclude this short notice of fossil land and fresh-water shells, than by a reference to the remarkable tertiary deposits of Steinheim, which have caused much discussion among palæontologists.

At Steinheim, in Würtemburg, in what was once the bed of an ancient lake, pits have been dug, revealing a succession of tertiary strata of clay, shell-sand and limestone, and, commencing with several forms of one species of Planorbis, or with related species, it matters little which view is adopted, the superimposed strata show a gradual divergence from the primal types until in the latest deposits some of these have become so altered as to have more resemblance to turbinate Valvatæ than to Planorbis. That the extraordinary changes here produced were the result of extraordinary conditions, can scarcely be doubted, but it cannot be denied that here the gradual change wrought in specific characters has received an important practical demonstration. The latest forms are *proved* to have been evolved from the earliest, for the whole history of the evolution is laid bare in the series of strata through which the innumerable specimens of these Planorbes are disseminated. It is believed that, in this case, the deposition of the strata was rather rapid, and therefore no great amount of time was required to make the transitions of form.*

* The Genesis of the Tertiary Species of Planorbis at Steinheim (Würtemburg). By Alpheus Hyatt. Anniversary Memoirs of the Boston Soc. of Nat. History, 1880.

Extension of Species, Genera and Families.—"The distribution of species in the fossiliferous beds is comparable to that of living species in space. In fact, we find a bed where each species has its maximum of numbers; above and below this bed, it is only represented by less numerous individuals, or has disappeared. If the locality where the first individuals of the species appeared is very distant from that in which the last of them occur, one can thus appreciate their geographical migrations during the interval.

"The study of the distribution of fossil genera, compared to that of the same genera living, will give interesting results and reveal considerable modifications in the condition of ancient seas and continents.

"We are led to believe that each genus has had a centre of creation or of diffusion;* or that (according to the development theory), each genus has become constituted within a determined region. The enormous geographical extension of several fossil genera, has supported the supposition that there existed many centres of creation, but the diffusion of embryonic marine Malacozoa is so easy, that it appears useless to have recourse to this hypothesis.

"All the genera of mollusks are not equally plastic, nor modified by time. Nautilus, Natica, Arca, Nucula, Chiton, Lingula, Terebratula, Rhynchonella, etc., have had a much greater longevity than the others, and more or less resemble living forms. Terrestrial and fluviatile mollusks are relatively less changed than marine mollusks; Melanopsis, Planorbis, Pupa of the ancient beds, scarcely differ at all from living forms.

"This resistance of certain mollusks to modification, contrasts with the extreme plasticity of types of echinoderms, reptiles and mammals, by which the thinnest stratigraphical horizons can be characterized.

"The cause of the persistence of these types is unknown. To say that with them the law of heredity is stronger than the law of variability, is not an explanation. Then again, many genera of mollusks, after enduring through several geological periods, suddenly become extinct. Others have made but an appearance, so to say, upon the surface of the globe. These

* L. Agassiz and Prof. E. Forbes have represented diagrammatically, the distribution of genera in time, as well as their duration, by means of a horizontal line crossing perpendicular columns representing the formations; its left extremity touches where the genus first occurs, its right extremity where it became extinct; the line is swelled or thickened according to the amount of development of the species in the various strata. For example, a line thus indicates that the genus has become extinct, and that it became most largely developed at the middle period of its duration; a line ◀ indicates that the genus has been developing to the present moment, which is, so far, its maximum.

last are the most precious for geologists, because they become characteristic."

TABLE OF CHARACTERISTIC GENERA.

Systems.	Genera and Sub-genera.
1. Cambrian, or Lower Silurian...	Cameroceras, Endoceras, Gonioceras, Pterotheca. Maclurea, Raphistoma, Holopea, Platyceras. Orthisina, Platystrophia, Porambonites, Pseudo-crania. Ambonychia, Modiolopsis, Lyrodesma.
2. Silurian..........	Actinoceras, Phragmoceras, Trochoceras, Ascoceras. Theca, Holopella, Murchisonia, Atrypa, Retzia. Cardiola, Clidophorus, Goniophorus, Grammysia.
3. Devonian..........	Bactrites, Gyroceras, Clymenia, Apioceras, Serpularia. Spirifera, Uncites, Merista, Davidsonia, Calceola. Stringocephalus, Megalodon, Orthonota, Pterinea.
4. Carboniferous...	Nautiloceras, Discites, Goniatites, Porcellia. Naticopsis, Platychisma, Metoptoma, Productus. Aviculo-pecten, Anthracosia, Conocardium, Sedgwickia.
5. Permian..........	Camarophoria, Aulosteges, Strophalosia. Myalina, Bakewellia, Axinus, Edmondia.
6. Trias...............	Ceratites, Naticella, Platystoma, Koninckia, Cyrtia. Monotis, Myophoria, Pleurophorus, Opis.
7. L. Jurassic.......	Belemnites, Beloteuthis, Geoteuthis, Ammonites. Alaria, Trochotoma, Rimula, Pileolus, Cylindrites. Waldheimia, *Thecidium*, Spiriferina, Ceromya. Gryphæa, Hippopodium, Cardinia, Myoconcha.
8. U. Jurassic.......	Coccoteuthis, Leptoteuthis, Nautilus. Spinigera, Purpurina, Nerinæa, Neritoma. Pteroperna, Trichites, Hypotrema, Diceras. Trigonia, Pachyrisma, Sowerbia, Tancredia.
9. L. Cretaceous....	Crioceras, Toxoceras, Hamulina, Baculina. Requienia, Caprinella, Sphæra, Thetis.
10. U. Cretaceous...	Belemnitella, Conoteuthis, Turrilites, Ptychoceras. Hamites, Scaphites, Pterodonta, Cinulia, Tylostoma. Acteonella, Globiconcha, Trigonosemus, Magas, Lyra. Neithea, Inoceramus, Hippurites, Caprina, Caprotina.
11. Eocene............	Beloptera, Lychnus, *Megaspira*, *Glandina*, *Typhis*. *Volutilithes*, *Clavella*, *Pseudoliva*, *Seraphs*, *Rimella*. Conorbis, Strepsidura, Globulus, *Phorus*, Velates. Chilostoma, Volvaria, Lithocardium, Teredina.
12. Miocene..........	Spirulirostra, Aturia, Vaginella, Ferussina. Halia, Proto, Deshayesia, *Niso*, *Cassidaria*, Carolia. Grateloupia, *Artemis*, *Tapes*, *Jouannetia*.
13. Pliocene.........	*Argonauta*, *Strombus*, *Purpura*, *Trophon*. *Yoldia*, *Tridacna*, *Circe*, *Verticordia*.

In the above table will be found the list of 13 geological systems, each having a certain number of special genera. Some of the genera cited, for example, Belemnites, have a greater extension, but are mentioned by reason of their abundance in a particular system. Names in italics are those of living genera.

The following table contains some of the larger genera arranged in the order of their appearance.

RANGE OF GENERA IN TIME.

Genera, arranged in their Order of Appearance.	Cambrian.	Silurian.	Devonian.	Carbonif.	Permian.	Trias.	L. Jura.	U. Jura.	L. Cret.	U. Cret.	Eocene.	Miocene.	Pliocene.
Lituites, Raphistoma, Obolus, . . .	–	–											
Camaroceras, Atrypa, Pterinea, .	–	–	–										
Gomphoceras, Bellerophon, Pentamerus, ...	–	–	–	–									
Orthis, Conularia, Murchisonia, . .	–	–	–	–	–								
Spirifera, Athyris, Posidonomya,	–	–	–	–	–	–	–						
Isoarca, ...	–	–	–	–	–	–	–	–	–	–			
Conocardium, Megalodon, Chonetes, ...		–	–	–									
Cardiomorpha, ...		–	–	–	–								
Orthoceras, Loxonema, Cyrtia, . .		–	–	–	–	–							
Pleurotomaria, Porcellia, ...		–	–	–	–	–	–	–	–	–	–		
Productus, Macrochilus, Streptorhynchus, ...			–	–	–								
Goniatites, Pleurophorus, ...			–	–	–	–							
Edmondia, Myalina, ...				–	–								
Acteonina, ...				–	–	–	–	–					
Terebratula, Pinna, Cyprina, ...				–	–	–	–	–	–	–	–	–	–
Lima, ...					–	–	–	–	–	–	–	–	–
Gervillia, Myoconcha, ...					–	–	–	–	–	–			
Ammonites, Naticella, Opis, ...						–	–	–	–	–			
Trigonia, Isocardia, Thecidium, . .						–	–	–	–	–	–	–	–
Cerithium, Plicatula, Cardita, . . .						–	–	–	–	–	–	–	–
Trochotoma, Tancredia, Gryphæa,							–	–					
Ancyloceras, Inoceramus, Unicardium, ...							–	–	–	–			
Astarte, Pholadomya, Corbis, . . .							–	–	–	–	–	–	–
Nerinæa, Goniomya, Exogyra, . .								–	–	–			
Terebratella, Limopsis, Neæra, Argiope, ...								–	–	–	–	–	–
Baculites, Cinulia, Radiolites, . . .									–	–			
Physa, Paludina, Unio, Cyrena, . .									–	–	–	–	–
Aporrhais, Tornatella, Pyrula, . .									–	–	–	–	–
Pectunculus, Thetis, Crassatella, .									–	–	–	–	–
Crenella, Chama, ...										–	–	–	–
Voluta, Conus, Mitra, Haliotis, etc.										–	–	–	–
Aturia, ...											–	–	
Helix, Auricula, Cyclostoma, . . .											–	–	–
Pseudoliva, Rostellaria, Seraphs,											–	–	–
Purpura, Strombus, ...												–	–
Argonauta, Tridacna, ...													–

"The same method of tabulation applied to families, that is, to groups formed of related genera, shows that the extinct families are relatively few in number. Among the reptiles, on the contrary, a large number of families and even several orders no longer exist (Dicynodonts, Labyrinthodonts, Enalliosaurians, Dinosaurians, etc.). The invertebrata, consequently, have varied less than the vertebrata.

"Woodward, who has prepared the following table, indicates only seven extinct families: Belemnitidæ, Ammonitidæ, Orthoceratidæ, Spiriferidæ, Orthisidæ, Productidæ, Hippuritidæ. It is evident that this list might be lengthened, but it can be said in general that the important fossil types of mollusks which no longer exist are relatively few in number.

RANGE OF FAMILIES IN TIME.

Systems of Strata.	Cambrian.	Silurian.	Devonian.	Carbonif.	Permian.	Trias.	L. Jura.	U. Jura.	L. Cret.	U. Cret.	Eocene.	Miocene.	Pliocene.	Recent.
Argonautidæ,													–	–
Teuthidæ—Sepiadæ,							–	–	–	–	–	–	–	–
Belemnitidæ,							–	–	–	–				
Nautilidæ,		–	–	–	–	–	–	–	–	–	–	–	–	–
Ammonitidæ,			–	–	–	–	–	–	–	–				
Orthoceratidæ,	–	–	–	–	–	–								
Atlantidæ—Hyaleidæ,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Strombidæ—Buccinidæ,										–	–	–	–	–
Conidæ—Volutidæ,										–	–	–	–	–
Naticidæ—Calyptræidæ,			–	–	–	–	–	–	–	–	–	–	–	–
Pyramidellidæ,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cerithiadæ—Littorinidæ,						–	–	–	–	–	–	–	–	–
Turbinidæ—Ianthinidæ,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fissurellidæ—Tornatellidæ,				–	–	–	–	–	–	–	–	–	–	–
Neritidæ—Patellidæ,							–	–	–	–	–	–	–	–
Dentaliadæ,			–	–	–	–	–	–	–	–	–	–	–	–
Chitonidæ,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bullidæ,							–	–	–	–	–	–	–	–
Helicidæ—Limacidæ,											–	–	–	–
Limnæidæ—Melaniadæ,								–	–	–	–	–	–	–
Auriculidæ—Cyclostomidæ,										–	–	–	–	–
Terebratulidæ,			–	–	–	–	–	–	–	–	–	–	–	–
Rhynchonellidæ,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Spiriferidæ—Orthidæ,	–	–	–	–	–	–	–							
Productidæ,	–	–	–	–	–									
Craniadæ—Lingulidæ,	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Systems of Strata.	Cambrian.	Silurian.	Devonian.	Carbonif.	Permian.	Trias.	L. Jura.	U. Jura.	L. Cret.	U Cret.	Eocene.	Miocene.	Pliocene.	Recent.
Pectinidæ,				–	–	–	–	–	–	–	–	–	–	–
Aviculidæ—Mytilidæ,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Arcadæ—Trigoniadæ,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Unionidæ,									–	–	–	–	–	–
Chamidæ—Myadæ,								–	–	–	–	–	–	–
Hippuritidæ,									–	–				
Tridacnidæ,													–	–
Cardiadæ—Lucinidæ,		–	–	–	–	–	–	–	–	–	–	–	–	–
Cycladidæ,								–	–	–	–	–	–	–
Cyprinidæ—Anatinidæ,	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Astartidæ,						–	–	–	–	–	–	–	–	–
Veneridæ—Tellinidæ,								–	–	–	–	–	–	–
Mactridæ,										–	–	–	–	–
Solenidæ,				–	–	–	–	–	–	–	–	–	–	–
Gastrochænidæ—Pholadidæ,								–	–	–	–	–	–	–

Three families are nearly extinct:—

Nautilidæ. Rhynchonellidæ. Trigoniadæ.

And several have passed their maximum, and become less varied and abundant than formerly, *e. g.*—

Tornatellidæ. Cyprinidæ. Anatinidæ.

The extinct families and genera appear to have attained their *maxima* more rapidly than their *minima*; continuing to exist, under obscure forms, and in remote localities, long after the period in which they flourished.

The introduction of new forms, also, is more rapid than the process of extinction. If four Palæozoic families disappear, twenty-six others replace them in the Secondary series; and three of the latter are succeeded by fifteen shell-bearing families in the Tertiary and existing seas.

In consequence of this circumstance, the number of types is three times greater in the newer Tertiary than it was at the Silurian period; and since there is no evidence or indication that the earth was ever destitute of life, either wholly or in part, it follows almost as a matter of necessity that the early types must have been more widely distributed and individually developed, than those of the present day.

From the following table it will be seen that the number of genera and families increases with an amount of regularity which cannot be accidental. Moreover, the relation of these numbers is not liable to be much altered by the progress of dis-

covery or the caprice of opinion. The *discovery* of new types is not likely to be frequent; the imposition of new names, in place of the old, will not increase the number of Palæozoic genera; and the establishment of fresh and arbitrary distinctions will affect all the groups in due proportion.

If the number of groups called "Systems" were reduced to seven (viz., three Palæozoic, three Secondary, and one Tertiary, as shown in the following table), then the *average* duration of a genus of shells would be equal to a System of Formations.

The duration of the smallest well-defined Families of shells is about equal to one of the three great geological divisions, or ages.—WOODWARD.

DEVELOPMENT OF FAMILIES, GENERA, AND SPECIES, IN TIME.

		Geological Systems.	Total of Genera.	Cephalopoda.	Gasteropoda.	Brachiopoda.	Conchifera.	Total Number of Species (d'Orbigny).	Families.	
PALÆOZOIC.	1	Cambrian......	49	12	11	15	11	362	18	32
		Silurian........	53	13	11	16	13	317	20	
	2	Devonian.......	77	14	20	23	20	1035	24	
	3	Carboniferous ..	79	11	26	19	23	835	30	
		Permian........	66	6	24	16	20	74	30	
SECONDARY.	4	Trias..........	81	9	25	16	31	713	35	57
	5	L. Jurassic.....	107	12	35	12	48	1502	42	
		U. Jurassic	108	13	36	9	50	1266	49	
	6	L. Cretaceous ..	123	20	41	9	53	784	52	
		U. Cretaceous ..	148	16	59	14	59	2147	56	
TERTIARY.	7	Eocene	172	4	85	11	72	2636	60	78
		Miocene........	178	3	97	11	76	2242	60	
		Pliocene	192	1	100	12	79	437	62	
		Recent.........	400	21	251	13	115	16,000	78	
		Recent and Fossil.	520	56	280	34	150	30,000	85	

A few words as to certain relations of fossil faunas with those now existing, will close this portion of our work.

Phillips has said that the Jurassic period has its parallel in the existing fauna of Australia. The Jurassic mammals are, in fact, Didelphians; and among Jurassic marine mollusks, Trigonia still exists in Australian seas.

"Forbes found the chalk deposits similar to those at the bottom of the Ægean Sea. Recently, Wyville Thompson has developed this hypothesis, after the study of the bottom of the Atlantic, and he believes the cretaceous period to have continued to the present time in the abyssal zone; where are living genera of echinoderms, sponges and crustaceans, similar to those of the white chalk. Unfortunately the conchological fauna only furnishes negative arguments; the relations of these mollusks being only with those of the pliocene and post-pliocene beds.

"The eocene fossils of the basin of Paris belong to genera now confined to tropical seas: Rostellaria, Oliva, Ancillaria, Voluta, Mitra, Pyrula, Xenophora, Typhis, Pseudoliva, Fusus, Vulsella, Crassatella, Cardilia, Corbis, Pholadomya, Perna, Nautilus, etc. The terrestrial genera of this basin: Cyclophorus, Cyclotus, Megaspira, Cylindrella, are now distributed through the intertropical regions of America. The eocene fauna of Europe thus has a more tropical character than its living fauna.

"The miocene genera of the basins of Bordeaux, Touraine, and Vienna are to-day distributed in the Indian Ocean, West Coast of Africa and Antilles: Ancillaria, Oliva, Eburna, Terebra, Cyllene, Strombus, Rostellaria, Ficula, Melongena, Fasciolaria, Turbinella, Sigaretus, Tugonia, Perna, Ungulina, etc.

"During the pliocene the Astrea polyps disappeared from the Mediterranean, the waters became colder, the great Pleurotomas became extinct, and the fauna took the characters of that which is now existing. A considerable cooling permitted the glacial species which existed in the Crag to penetrate to the Mediterranean.

"Finally, the quaternary period is that, for which great oscillations of the earth, cataclysms, displacements of currents, are invoked to explain certain geological and palæontological facts. The axis of rotation of the earth itself has been displaced by certain theorists. The explanation of these hypotheses would take us too long. Suffice it to say that in our quaternary beds are found Alpine terrestrial shells mixed with those now living upon the plains, and with exotic types (Corbicula); just as they contain mammoths, reindeer, hippopotami and lions—an assemblage which now appears to us paradoxical. This last period, so close to us is thus the most obscure. It renders palpable the inanity of our science in presence of the great geological and palæontological problems which still remain unsolved. What, then, is it which has chiefly determined the character of the present zoological provinces? What law, more powerful than climate, more influential than soil, and food, and shelter; nay, often seemingly producing results opposed to *à priori* probability, and at variance with the suitableness of conditions?

"The answer is, that each fauna bears, above all things, the impress of the age to which it belongs. Each has undergone a series of vicissitudes up to the time when its barriers became fixed, and after its isolation it has known no further change, but decline."

The number of living and fossil species of each genus of mollusca will be stated in the following pages, so far as they can be ascertained. The following table of the relative numerical development of the orders and families, is taken from Woodward and shows the extent of conchological knowledge twenty-five years ago:—

	Recent.	Fossil.
CEPHALOPODA. *Dibranchiata.*		
Argonautidæ, .	4	2
Octopodidæ, . .	63	—
Teuthidæ, . . .	104	31
Belemnitidæ, . .	—	140
Sepiadæ, . . .	30	16
Spirulidæ, . . .	3	—
	204	189
Tetrabranchiata.		
Nautilidæ, . . .	6 }	593
Orthoceratidæ, .	— }	
Ammonitidæ, .	—	1600
	6	2193
GASTROPODA. *Prosobranchiata.*		
Strombidæ, . .	87	393
Muricidæ, . . .	993	703
Buccinidæ, . .	1144	352
Conidæ, . . .	856	462
Volutidæ, . . .	686	210
Cypraeidæ, . .	227	97
Naticidæ, . . .	268	340
Pyramidellidæ, .	216	394
Cerithiadæ, . .	192	610
Melaniadæ, . .	424	50
Turritellidæ, . .	329	290
Littorinidæ, . .	410	220
Paludinidæ, . .	217	110
Calyptræidæ. . .	160	101
Turbinidæ, . .	855	906
Haliotidæ, . . .	104	136
Fissurellidæ, . .	201	76
Neritidæ, ...	428	103
Patellidæ, . . .	368	104
Dentaliadæ, . .	50	125
Chitonidæ, . .	250	37
	8465	5819
Pulmonifera.		
Helicidæ, . . .	4750	316
Limacidæ, . . .	93	4
Limnæidæ, . .	332	185
(Marine), . . .	193	37
(Ditto, shell-less),	36	—
	5404	542
Operculated Pulmonifera.		
Cyclostomidæ, .	903	45
Aciculidæ, . . .	28	1
	931	46
Tectibranchiata.		
Tornatellidæ, . .	62	166
Bullidæ, ...	168	88
Aplysiadæ, . .	84	4
Pleurobranchidæ,	28	5
Phyllidiadæ, . .	14	—
	356	263
Nudibranchiata.		
Doridæ, ...	160	—
Tritoniadæ, . .	38	—
Æolidæ, . . .	101	—
Phyllirhoidæ, .	6	—
Elysiadæ, . . .	13	—
	318	

	Recent.	Fossil.
Nucleobranchiata.		
Firolidæ, . . .	33	1
Atlantidæ, . .	22	159
	55	160
Pteropoda.		
Hyaleidæ, . . .	52	95
Limacinidæ, . .	19	—
Clionidæ, . . .	14	—
	85	95
Brachiopoda.		
Terebratulidæ, .	67	340
Spiriferidæ, . .	—	380
Rhynchonellidæ,	4	422
Orthidæ, . . .	—	328
Productidæ, . .	—	146
Craniadæ, . . .	5	37
Discinidæ, . . .	10	90
Lingulidæ, . .	16	99
	102	1842

	Recent.	Fossil.
Conchifera.		
Ostreidæ, . . .	426	1362
Aviculidæ, . .	94	638
Mytilidæ, . . .	217	331
Arcadæ, . . .	360	1142
Trigoniadæ, . .	3	139
Unionidæ, . . .	549	58
Chamidæ, . . .	50	62
Hippuritidæ, . .	—	103
Tridacnidæ, . .	8	3
Cardiadæ, . . .	200	360
Lucinidæ, . . .	178	446
Cycladidæ, . .	176	144
Cyprinidæ, . .	176	956
Veneridæ, . . .	600	829
Mactridæ, . . .	147	58
Tellinidæ, . . .	560	388
Solenidæ, . . .	63	81
Myacidæ, . . .	121	334
Anatinidæ, . .	246	400
Gastrochænidæ, .	40	35
Pholadidæ, . .	81	50
	4295	7419

General Summary.

	Recent.	Fossil.
Dibranchiata, . .	204	189
Tetrabranchiata, .	6	2193
Prosobranchiata, .	8465	5819
Inoperculated Pulmonifera, . . .	5404	542
Operculated Pulmonifera, . . .	931	46
Tectibranchiata, .	356	263

	Recent.	Fossil.
Nudibranchiata, .	318	—
Nucleobranchiata,	55	160
Pteropoda, . . .	85	95
Brachiopoda, . .	102	1842
Conchifera, . . .	4295	7419
	20,502	18,568

NOMENCLATURE.

It is a reproach to natural science, and to no department thereof more than to conchology, that most of its votaries consider the determination of species and genera its legitimate end; that is, that they are more actuated by the selfish ambition of acquiring reputation than by the love of knowledge. As the builder finds it convenient to express the kinds of instruments used in his labor, by technical names, so do naturalists find necessary a succinct designation of the subjects of their studies; and the naming and technical description of species, in the same manner distinguishes for us the implements which we should use in our investigation of nature—implements by which the Great Builder has worked, in which He has expressed His thought. The proper acquisition of a language requires the preliminary knowledge of its grammar, the knowledge of letters precedes reading: even so, the simple name of a species, then of a genus, and its recognition when met with or referred to, forms the mere alphabet of science, from which we proceed gradually to the consideration of individual properties, then to intimate and to wider relationships, until we are fortified with sufficient knowledge to generalize. In these latter days generalizations are numerous enough, but unfortunately they are usually the product of minds not furnished with the requisite intimate knowledge of the factors upon which they build their generalizations.

Prior to the works of Linnæus binomial nomenclature was employed in natural history descriptions by several authors, and notably by Tournefort in botany; yet Linnæus was the first to use it throughout the animal and vegetable kingdoms, and he has accordingly been considered the founder of a system which he only extended and perfected. His principal rules still form the foundation of modern nomenclature. They are, as at present generally accepted, these: Every name applied to a natural object should consist of a generic followed by a specific name, each consisting of a single word. These names should be of Latin or Greek derivation, or Latinized if otherwise derived. The generic name is always with a capital initial letter, the specific name with a small initial, with the exception of personal, including mythological names, and of those which denote localities. With regard to these exceptions the practice is far from uniform; some strict Latinists writing all specific names with a small initial, whilst the most of authors give the capital initial to personal, and a respectable minority of them to geographical names. The former receive a genitive, the latter an adjective form.

Originally names were supposed to express qualities of the

objects to which they were applied, but the vast multiplication of descriptions of natural objects has caused some doubt as to the propriety of using such names, especially for species: thus, *Paludina viridis*, meaning the green paludina, a good-enough designation at one time, becomes confusing when fifty other equally green species of the same genus have become known to us, and so on, of other qualities, and especially of those designated comparatively—as small, smallest, largest, etc. A specific name which expresses no quality of the species and thus only becomes associated with the latter arbitrarily is decidedly favored by many modern students. Genera are usually printed in caps, species in small caps, synonyms (of which more hereafter) in italics; but when these names occur in the body of a text they are indifferently printed in italics.

All names, generic or specific, are followed by the full or contracted name of the author thereof. Apart from the personal considerations causing the adoption of this practice, there are others of purely scientific importance. The principal of these is, that owing to the insufficiency of a description or the stupidity of those who fail to understand a sufficient diagnosis, the name originally applied by one author to some object, comes to be applied by another and subsequent author to another object, usually more or less related to the first; or an original description may prove to cover two or more distinct species, and then one of these must be selected by a subsequent author to retain the original name, whilst the others receive new ones. In such, and other similar cases, the addition of the author's name informs us that the species referred to is, for instance, that named by Linnæus, and *not* the different object similarly named in error by Lamarck.

The love of scientific reputation, haste, the want of the painstaking and discriminating qualities which should distinguish a naturalist, above all the practice of working in localities where reference to the many thousands of publications on natural history is inconvenient or impossible, have led to a deplorable duplication of generic and (principally) specific names and diagnoses. It has been universally agreed to prefer in all such cases the name first published with a sufficient diagnosis, the other or subsequently printed names becoming synonyms. It is also generally agreed by conchologists to accept no specific names dated earlier than 1758, when Linnæus published the 10th edition of his Systema Naturæ. The exceptions are mainly generic names, some of the great Swede's predecessors far surpassing him in their appreciation of generic characters. For many of the older and generally less accurately described objects the synonymy has become prodigious, and even at the present day, some of the reasons given above are so active in the pro-

duction of synonyms that these form an immense annual crop, the extirpation of which occupies most of the time of those engaged in systematic work.

I give examples of the synonymy of four common European species from Fischer:—

SCROBICULARIA PIPERATA, Gmelin, sp.
Calicinelle, Adanson.
Mactra piperata, Gmelin.
Mactra Listeri, Gmelin.
Venus gibbula, Gmelin.
Trigonella plana, Da Costa.
Mya Hispanica, Chemnitz.
Venus borealis, Pennant.
Mya Gaditana, Gmelin.
Scrobicula arenaria, Schumacher.
Mactra compressa, Pulteney.

SAXICAVA ARCTICA, Linné, sp.
Mya arctica, Linné.
Solen minutus, Linné.
Donax rhomboidea, Poli.
Donax iris, Olivi.
Didonta bicarinata, Schumacher.
Biapholus spinosus, Leach.
Pholobia præcisa, Brown.
Rhomboides rugosus, Blainville.
Hiatella monoperta, Bosc.
Mya elongata, Brocchi.

AKERA BULLATA, Müller.
Bulla akera, Gmelin.
Bulla soluta, Salis.
Bulla Norwegica, Bruguière.
Bulla resiliens, Donovan.
Bulla fragilis, Lamarck.
Akera flexilis, Brown.
Akera Hanleyi, Adams.
Eucampe Donovani, Leach.
Bulla elastica, Sandri.

NASSA COSTULATA, Renieri, sp.
Buccinum costulatum, Renieri.
Buccinum Cuvieri, Payraudeau.
Buccinum Ferussaci, Payraudeau.
Planaxis lineolata, Risso.
Planaxis riparia, Risso.
Buccinum flexuosum, Costa.
Buccinum elegans, Costa.
Buccinum variabile, Philippi.
Buccinum tessellatum, Scacchi.
Buccinum unifasciatum, Kiener.

"The multiplication of synonyms having made it desirable (as we have shown) to place the *authority* after each name, another source of evil has arisen; for several naturalists (fancying that the *genus-maker*, and not the *species-maker*, should enjoy this privilege) have altered or divided almost every genus, and placed their signatures as authorities for names given half a century or a century before by Linnæus or Bruguière. The majority of naturalists have disowned this practice, and agreed to distinguish by the addition of 'sp.' the authorities for those specific names of which the generic appellations have been altered. The *type* of a genus should be the species which best exhibits the characters of the group, but it is not always easy to follow out this rule: and consequently the first on the list is often put forward as the type."—WOODWARD.

Latin was formerly the universal language of learning, and so became for a long period the only recognized language of science; in many cases descriptions not written in Latin were entirely ignored. Habit, and the authority of several scientific bodies

still cause it to be employed in most cases for a short characteristic description; but the numerous minor points—especially comparative characters now constituting the really essential portions of the description, are usually given in the vernacular of the author. Latin is not well adapted to the refinements of modern species-making and its final disuse is probably not far distant. Meantime the student is subjected to much inconvenience, unless his preparation embraces a useful knowledge of at least the Latin, English, German, French and Italian languages.

The Latin diagnosis, as now written, is usually worthless for the purpose of identification. It is simply a ceremonial through which the author becomes invested with the title to a specific name; it does not and cannot, and is not ordinarily intended to define his property with sufficient accuracy to prevent trespass on his rights by others; therefore it becomes a trap for the unwary and ambitious. On the other hand, the indefiniteness of the usual diagnosis permits its author the greatest latitude in shifting its object from species to species; or, if he is enterprising, in capturing some of the species diagnosed at a later date by his brother conchologists.

It remains to define the meaning of the words species, variety, genus, family, etc.

All the specimens or individuals, which are so much alike that we may reasonably believe them to have descended from a common stock, constitute a species. A species, therefore, must be capable of reproducing its like, subject to no other variations than those occasioned by the slow operation of changes of environment, food, etc. For the old idea of the immutability of species, each specially created in its present form, must be substituted that of practical immutability at a given period. Whilst some species have preserved their characters intact since the tertiary epoch, others show a gradual evolution of characters, distinguishing them from their common progenitor. Forms differing from specific types in an inferior degree may fall within the range of individual variation, and their characters, individual only, return to the parent stock; or, the combined operation of the laws of heredity, of selection, of environment may perpetuate in their descendants the differential characters and so, according to the degree of development of these characters we have varieties or new species. In fact varieties, conchologically understood; that is, possessing transmissable characters of sufficient importance to require naming and description are incipient species. Form, coloration and sculpture furnish the principal characters of species, whilst genera are collections of species possessing some more important character in common, whether derived from the animal or shell. Subgenera possess the essential generic character and in addition some character of

inferior importance peculiar to the subgeneric group. Subgenera may thus be regarded as incipient genera. Families are groups of allied genera possessing in common some character (generally structural); and subfamilies are distinguished by somewhat inferior but peculiar characteristics from the families. Families usually receive the name of the principal genus with the termination *idæ*. Thus the genus Helix belongs to the family Helicidæ. Subfamilies take the termination *inæ* with the name of the principal genus: thus we have the family Muricidæ, with the subfamilies Muricinæ and Purpurinæ for the groups of genera typified by Murex and Purpura. Suborders, orders, subclasses and classes are assemblages similarly constituted; only in each step made, the characters pervade a larger group of species, etc., and thus become more and more important in the structure and economy of the animal.

In an ideal classification each group of similar systematic value would possess structural characters of equal importance. If such military order and subordination existed in nature, it might readily be perverted by our want of perception and judgment; but many naturalists have become satisfied that the same laws which have produced variation in the individual, work to produce variation in every characteristic, be it of minor or major importance, and therefore the sharp lines of demarkation, indicated by the systematic scheme do not exist in nature, they are fictions necessary in classification, for the purpose of indicating certain agreed-upon stages of a continuous chain of differentiation. Sufficient evidence has accumulated from the study of palæontology, embryology and comparative anatomy to fully sustain this evolutionary idea of nature, as to most of the inferior systematic divisions, but the evidence is still insufficient to show conclusively the evolution of orders and classes within the subkingdom Mollusca, or of that subkingdom with the others from some common ancestral type. The classes and principal orders of the mollusca exhibit their structural characteristics (so far as these can be indicated by the shell and other preserved portions of the animal) from their first geological appearance. It may be added that certain genera have maintained these original characters from the older fossiliferous deposits to the present time.

"Great difficulty has always been found in placing groups according to their affinities. This cannot be effected in—the way in which we are compelled to describe them—a single series; for each group is related to *all* the rest; and if we extend the representation of the affinities to very small groups, any arrangement on a plane surface would fail, for the affinities radiate in all directions, and the 'network' to which Fabricius likened them, is as insufficient a comparison as the 'chain' of older writers."—WOODWARD.

CLASSIFICATION.

A detailed history of the progress of the science of conchology from the most ancient period to the present time, would be both interesting and instructive: want of space prevents the insertion of such an account here.

The following rapid sketch of the history of the modern classification of mollusks and exposition of a system, based principally on the lingual armature of the gastropods, is translated and condensed from a paper by the late Prof. Mörch, published in the *Journal de Conchyliologie* (xv, 232, 1867).

Ancient authors classified shells according to external forms, from which they derived generic names. Linnæus was the first to introduce characters independent of the form of the shell; as the teeth and ligament in bivalves, plications and sulcations in univalves. By these characters Voluta and Turbinella were separated from Murex, Buccinum, etc.

Linnæus classed the species of each genus, according to the height of the spire, in analogous sections, of which the most were adopted by Bruguière as distinct genera. Thus the following genera were terminated by a section "turrita," Bulla by Achatina; Buccinum by Terebra; Strombus by Potamides and Pirena; Murex by the spiny Cerithiæ; Trochus by Telescopium and Pyramidella; Turbo by Turritella; Helix by Melania and Limnæa.

Linnæus was the first to take the form of the animal into consideration as a generic character; but he indicated only five different types of animals, namely: Doris, Limax, Tethys, Sepia, and Ascidia. Thus the animal of Chiton is a Doris, that of Argonauta a Sepia; bivalves with simple mantle are Ascidiæ (Solen, Mya, Pholas), and those with fringed mantle Tethys. Nearly all the univalves are called Limax.

Adanson must be regarded as the founder of Malacology, but the number of mollusca known in his time was too few to permit the elimination of the principal systematic divisions. He was also the first to take into consideration the operculum and the shell structure as characters, and to divide the bivalves according to the number of muscular impressions.

The system of Cuvier, based on the respiratory organs, induced a great reform in Conchology. The shells of pulmonate mollusks, heretofore dispersed by all authors, with the exception of Adanson, among the pectinibranchs, were assembled in one group, which still remains intact. Although it may be difficult to indicate by a description the difference which exists between the shell of a pulmonate and that of a branchiate mollusk, there are, nevertheless, few collectors who will not recognize it at

sight. Ancient authors, like Lister, Müller, Chemnitz and Schröter, who have treated upon the terrestrial and fluviatile mollusks specially, have rarely mistaken these shells; and a mistake of this nature is very rare among modern authors, although a few instances might be cited. One can say only that the shells of terrestrial pulmonates are inoperculate, with entire apertures (holostomate), never nacreous, rarely spirally striated; but one cannot give a single character expressible by words, notwithstanding that all who have seen a certain number of species can distinguish them with facility. The fluviatile mollusks, nearly always unicolored, although they may resemble marine groups as to form, can also be readily separated at a glance.

Ferussac and several modern authors have thought that all mollusks inhabiting dry land respire by the aid of a pulmonary sack, but nothing is less certain. Among branchiferous genera, the Littorinas and many trophical Neritinæ, live a long while out of water. The larvæ of Auricula swim in the sea, and consequently possess a branchial respiration during this period of their life. According to Semper, Ampullaria has an accessory pulmonary sack. If the inoperculate pulmonates are considered, with so much reason, as an incontestable group, it is because, apart from their pulmonary sack, they possess other collateral characters of equal importance, as for example, the position of the eyes, the organization of the mouth and of the sexual organs.

The rest of the gastropods, after the exclusion of the pulmonates, were divided by Cuvier into several very natural groups, according to the form and position of the branchiæ (nudibranchs, heteropods, tectibranchs, scutibranchs, cyclobranchs). The magnificent work of Quoy and Gaimard is full of precious material for the amelioration of the great group of pectinibranchiates. The Trochidæ are here shown to be inseparable by their characters, as much external as internal, from Haliotis and other scutibranchs, notwithstanding the presence of an operculum and an elevated spire in the former. At the same time the great systematic value of the nacre was proved. Stomatella, with an animal similar to the Trochidæ, has a nacreous interior, whilst Sigaretus, with a non-nacreous shell, has an animal like Natica. The relations between the enamel of the shell of Cypræa, Oliva and Natica, and the structure of the animal were shown for the first time by the same work. As it has become evident to me that the presence of an operculum and the height of the spire, considered heretofore as prime characters, have, in reality, little value in distinguishing the families, I have sought to divine the natural affinities of mollusks according to the sculpture and structure of their shells.

In 1847, Lovén published four plates of lingual dentition, repre-

senting 94 species of cephalous mollusks. The first glance at these plates suffices to show clearly that the lingual armature confirms the most of the ancient divisions. Thus, the Cephalopods, Pteropods, Heteropods, Scutibranchs (in the sense of Quoy and Gaimard, including the Trochidæ), are also distinguished by the teeth. The conchological analogy between Pleurotoma and Conus had already been shown by Sowerby. There existed, nevertheless, certain anomalies until then inexplicable, on account of the small number of observations made, as for example, the analogy between Philine and Scaphander and the Gymnobranchs. The want of teeth must not be considered as fatal to the systematic value of characters found in these organs. The teeth accepted as an exclusive character have, doubtless, inconveniences, as in the whole animal kingdom, but it cannot be denied that all other organs taken as exclusive characters offer still greater inconveniences. Thus the shell may be wanting in very similar animals (for example, Notarchus, Aplysia; Pterotrachea, Cardiopoda; Limax, Tebennophorus . The operculum is often wanting in the adult, although the young may have it. There are even operculated and inoperculated species in the same genus, as understood by many modern authors (for example, Pleurotoma and Bela, Oliva and Olivella, Yetus, Voluta and Lyria, Spirialis and Limacina, Proserpina and Helicina). The organs of respiration and locomotion may be entirely wanting in closely related species (Firoloidea and Phyllirhoë).

Lovén has characterized the families according to the teeth, and has given Latin diagnoses. In 1848, Troschel (*Handbook of Zoology*) mentions the teeth as characters of all his suborders, and introduces into the nomenclature, for the first time, several new names taken from the form of the teeth. Thus the section *H.* of Lovén is called Rhipidoglossa, including the Scutibranchs, that is to say, Neritidæ, Trochidæ, Haliotidæ and Fissurellidæ. For the section *L.* of Lovén he proposed the term Toxoglossa. Tænioglossa corresponds to the Ctenobranchous Gastropods, having seven rows of teeth (3. 1. 3.), excepting the operculate pulmonates, although they may have the same form of teeth. Thus Cyclostoma is placed in another suborder from Valvata and Paludina. The Heteropods, which have the same general disposition of the teeth as Tænioglossa, are regarded as an order, with the same value as the Gastropods—an opinion still maintained by this author.

In 1853, Dr. Gray (*Proc. Zool. Soc.*, 32), in adopting the names of Prof. Troschel, proposed several new groups, according to the form of the teeth.

1. Hamiglossa. Three ranges of teeth (1. 1. 1), the lateral versatile. This last character appears to Prof. Mörch to be

consequent upon the rupture of the tissues; it is observed above all when there is abundance of water under the compressor.

2. Odontoglossa. Including only Fasciolaria, Mitra and Turbinella, which have the same form of teeth, but of which the laterals are not versatile.

3. Rachiglossa. A single row of teeth (0. 1. 0.); the laterals having disappeared.

4. Dactyloglossa. Only differing from Tænioglossa by their lateral teeth, which are wider, with very profound comb-like incisions.

5. Ptenoglossa. Teeth nearly subulate, in numerous longitudinal rows; Scalaria, Acteon.

6. Gymnoglossa. No teeth: Architectonidæ, Acusidæ, Cancellariadæ, Pyramidellidæ. But teeth have been since discovered in the three first families. There are, doubtless, many genera indubitably deprived of teeth, without, for that reason, forming separate groups.

Gray has regarded these different groups as having a systematic value inferior to that of the form of the proboscis. Thus he divides the Ctenobranchiates into two suborders: the Proboscidifera, which he believes zoophagous, furnished with an entirely retractile trunk, and the Rostrifera, having a contractile, but not retractile, trunk, and sometimes very long, as in Struthiolaria, which he supposes phytophagous.

The author has thus placed the sections of Toxoglossa, Gymnoglossa, Ptenoglossa and Tænioglossa in these two suborders. The small value of the retractile trunk as an ordinal character is proved for example in the Bullidæ (*Bulla vexillum* possessing a very long retractile trunk). Odostomia has also a very long retractile trunk; and the rather short trunk of Janthina is very often retracted into the head.

In his Guide to the British Museum, 1857, Dr. Gray has reunited all the Toxoglossæ in a single division Toxifera, still retaining for the other divisions the separation into two widely removed sections. The name of Ctenoglossa is changed to Ptenoglossa; the name Trapezodonta is proposed for the Coriocellæ, the teeth of which do not appear to Prof. Mörch to differ from the Tænioglossæ except in the want of the two internal teeth on each side (1. 0. 0. 1. 0. 0. 1.). Heteroglossa is proposed for the Cyclobranchiates.

In 1854, Mörch divided the cephalophora into five great groups, namely: I. Rhipidoglossata (including the Cyclobranchs); II. Ptenoglossata (Pulmonata, Tectibranchiata, Janthinidæ); III. Tænioglossata (including Pneumonopoma and Heteropoda); IV. Hamiglossata (Proboscidea of Troschel, Odontoglossa and Rachiglossa of Gray); V. Toxoglossata (including Pleurotoma

and Terebra. In 1857, Mörch reduced the five principal divisions to three, namely:

I. Musivoglossata (corresponding to the Ptenoglossata of 1856, but thus modified because this name has been used by M. Troschel to characterize the group of Janthinæ and Scalariæ, Pulmonata and Tectibranchia.

II. Arthioglossata, including: 1. Tænioglossata; 2. Ancistroglossata; 3. Toxoglossata.

III. Rhipidoglossata, with the section Orthodonta (Cyclobranchiates).

In 1861–2, circumstances having induced Prof. Mörch to study the Planarians, he was struck with their great affinity with the Pellibranchs, above all in the generative organs; this caused him to make a comparative revision of the genital organs of mollusks. He then ascertained that those belonging to his first division were androgynous and furnished with a retractile male organ; whilst those of the second section were diœcious, with a non-retractile male organ; and those of the third section differed from the others by the want of a copulative organ. In other words, he had thus arrived, independently, at the three groups proposed in accordance with the sexual organs by Blainville and Latreille.

In 1859, Mörch perceived that Mollusks were divided into two great groups, according to the construction of the heart and that these groups accorded also with those furnished by the sexual organs. Thus the Phanerogama, Latr., with a retractile or non-retractile copulative organ, have a heart with a single auricle (Monotocardia, Mörch), whilst the Agama, Latr., which have no copulative organ, have a heart with two auricles (Diotocardia, Mörch). It appears, doubtless, rather strange that the acephala should form a group with a considerable portion of the gastropods (Rhipidoglossa and Heteroglossa), but there exists a similar division among the vertebrates, namely: the cold-blooded vertebrates, where the fishes are united with reptiles, the latter provided with well-developed locomotive organs analogous to those of the mammalia.

Stimpson proposed (*Am. Jour. Sci.*, 2 ser. 37, p. 47, 1864), to form a group Anandria, characterized by the want of a male copulative organ. This group includes the Melanians of North America, the Vermetidæ and Turritellidæ and certain Cerithiæ. M. Rüppel, however, has figured a male organ in *Vermetus inopertus*, and M. Lacaze-Duthiers has found a single male individual which circumstances did not permit him to examine sufficiently. As to the Melanians, they may want an external conical male organ, but the sexual character is with them represented by a groove. In the Agama of Latreille there is not the least external sexual difference.

Mr. Mörch believes that naturalists of the most opposite schools could agree to a scheme of classification which he submits, as follows:

Sub-Kingdom 3.—MOLLUSCA.

Supra-class 1. PHANEROGAMA Latr. (Monotocardia, Mörch).

Class I. ANDROGYNA (Hermaphrodita, Latr.).

Order 1. GEOPHILA, Fer (Stylommatophora, A. Schmidt). *Phyllovora* with jaw. *Agnatha* without jaw.

Order 2. HYGROPHILA; eyes at the interior base of the tentacles. Planorbis, Physa, Limnæa, Siphonaria, Ancylus, Auricula.

Order 3. TECTIBRANCHIA (Pomatobranchia), Pyramidella (connecting with the preceding genus), Obeliscus, Odostomia, Chemnitzia, Actæon, Bulla, Aplysia, Notarchus. Gasteropteron connecting with the Pteropods.

Order 4. PTEROPODA.

1. *Gymnosomata.* Clione, Pneumodermon.
2. *Thecosomata.* Clio, Hyalæa, Limacina, Heterofusus.

Order 5. GYMNOBRANCHIA.

1. *Pygobranchia.* Doris, etc.; branchiæ near the anus.
2. *Pleurognatha.** Pleurophyllidia, Dendronotus, Tritonia, Bornella, Æolis, Glaucus, Phyllirhœ.

Order 6. PELLIBRANCHIA. Tethys, Chioræa, Hermæa, Elysia, Limapontia, Pelta.

All these mollusks are placed at the head of the gastropods by Cuvier. Messrs. Troschel and Gray arrange them between the Acephala and Patella, considering androgynism as probably a character of absolute inferiority; but the Acephala have generally separated sexes.

Class II. DIOICA, Latr. (Exophallia, Mörch).

Order 1. TÆNIOGLOSSATA, Troschel.

This is the only division where the family groups and their reciprocal relations do not appear to Mörch to be perfectly clear. In any case, it appears incontestable that all mollusks having seven ranges of teeth form a characteristic group. Recently, Troschel has divided the Tænioglossata into three groups according to the trunk:

1. Trunk not retractile.
2. Trunk retractile only by the end.
3. Trunk retractile from the base.

These differences appear to originate solely in the different length of the trunk. The old divisions Holostomata and Entostomata are not very faulty.

* Dr. Möbius has recently shown that the Doridæ have also lateral jaws, although very little developed.

Troschel's first section commences with the Pulmonates, but Mörch considers very doubtful their having a true pulmonary sack closed by a contractile opening. Gray calls these respiratory organs of the Cyclostomæ "gills vascular, branched," and "gills indistinct in the form of series of vessels on the inner surface of the mantle."

"*Sect.* 1. Fam. 1, Aciculacea; 2. Pomatiacea; 3. Cyclotacea; 4. Cyclostomacea.

Sect. 2. Respiring by branchiæ and lungs; Ampullariacea.

Sect. 3. Branchiferous Holostomata. Fam. 1. Valvatæ; 2. Hydrobiæ (Lithoglyphus); 3. Littorinidæ; 4. Rissoidæ; 5. Paludinidæ; 6. Melaniidæ; 7. Potamidæ; 8. Cerithiidæ (Planaxis).

The Aporrhaidæ form a passage between the Cerithiidæ and Strombidæ. Crepidula and Capulus belong with Hipponyx in a group, notwithstanding differences in the labial palpi. Onustidæ connects the Crepidulidæ with the Heteropods.

Ovulidæ (including Pedicularia). generally placed close to Cypræa, is strongly distinguished from the latter by its non-retractile proboscis. Notwithstanding this character, Mörch considers it intermediate between Cassis and Cypræa.

The 3d section of Troschel (trunk retractile from the base) contains the genera which Mörch united in 1852 in the family Tritonidæ, namely: Cassis, Dolium, Pyrula, Triton, Ranella.

Onchidiopsis, Velutina, Marsenia, Tylodina, form, probably, a very natural division, notwithstanding the want of the two lateral teeth in Marsenia. The family Naticidæ stands next in relationship. It is in the Tænioglossata that the greatest incertitude relative to a natural grouping of the families exists; in the orders which follow, these relationships are more positively defined.

Order 2. RHACHIGLOSSATA, Troschel. Never more than three rows of teeth. All mollusks having coriaceous ovisacs, heretofore known, belong to this order.

Sect. 1. Marginella. Voluta. Volutilithes, connecting with Cryptochorda and Harpa: Oliva, Ancillaria, Bullia, Nassa, Mitra, Columbella.

Sect. 2. Buccinum. Fusus. Fasciolaria. Turbinella. Purpura. Murex, Magilus.

Order 3. TOXOGLOSSATA. Two rows of teeth. Stimpson has recently discovered a median tooth in *Clionella sinuata*, Born. Conus, (Borsonia?), Pleurotoma, Clionella, Terebra, Cancellaria, Halia, Lachesis?

Supra-class II. AGAMA, Latr. (Diotocardia, Mörch).

Mollusks without copulative organ. Heart with two auricles, placed nearly always around the intestine.

Class 1. EXOCEPHALA, Latr. (Pseudophallia, Mörch).

Order 1. RHIPIDOGLOSSA, Troschel. Proserpina, Helicina, Hydrocena, with sessile eyes.

Gray, in figuring the teeth of Proserpina (Ceres), formed for this mollusk a distinct suborder, alongside of the Neritinæ, which he called Pseudobranchia. In the same year (1857) Mörch placed Helicinæ in the Rhipidoglossates, with Neritina, notwithstanding the want of an operculum in Proserpina, an example followed by Troschel with some hesitation.

Eyes sessile. Shell not nacreous. Neritina, Nerita.

Shell nacreous. Phasianella, Turbo, Trochus, Margarita, Stomatia, Haliotis.

Eyes not petiolate. Shell not nacreous. ? Scissurella, Emarginula, Fissurella, the affinity of which with Haliotis, is incontestable.

Order 2. HETEROGLOSSATA, Gray. (Orthodonta, Mörch, Docoglossa, Troschel.) Patella, Tectura, Pilidium, etc., Chiton.

Class 2. ACEPHALA, Cuvier. (Endocephala, Latreille; Dithyra, Anst.)

Dimyaria (Plagymiona, Latr.).

Heteromyaria (Mytilacea).

Monomyaria (Mesomyona, Latr.).

Notwithstanding that the systematic value given above to these different groups varies from that of other authors, their order of succession differs but little from Cuvier. The separation of the Rhipidoglossata (Pectinibranchiates) and Scutibranchiates, is the principal change. The arrangements of Gray and Troschel differ still more, above all in the Androgyna, which are placed between the Heteroglossa and Acephala, probably because androgynism is considered as a character of inferiority; notwithstanding that the Acephala, which are inferior, have the sexes separate, with some exceptions. The little division, Ptenoglossa, including only Janthina, Scalaria, Solarium, is placed in the system of Troschel, between the Rhachiglossa and Rhipidoglossa. If we admit a special concordance between the teeth of these three groups, Mörch still does not consider the difference sufficient to justify a separation from the Androgyna. Janthina appears to him more close to the Pteropods by its lateral wings, and Scalaria, notwithstanding the position of the eyes, approaches Chemnitzia.

As in the entire animal kingdom, the greatest difference exists amongst authors relative to the value of the swimming organs. Latreille has united the Cephalopods and Pteropods in a single division Pterygia, to which he attributes the same value as to his Apterygia, comprehending all other mollusks. Gegenbauer

and Huxley have demonstrated that the Pteropods are veritable Gastropods furnished with a pair of accessory swimming organs. Already the discovery of Gasteropteron has shown the little value of the Pteropods as a division equivalent to the Gastropods. The Heteropods merit still less to be considered as a division of equal value.

The late Prof. O. A. L. Mörch, although attaching as much systematic value to the lingual dentition as any other conchologist, acknowledged that no single organ could be used in classification unless its differential characters accorded with differences of other portions of the animal and shell; but he endeavored to show that conchologists have erred in estimating too highly for systematic purposes the *form* of the shell, whilst neglecting other external characters, such as sculpture, structure (nacreous, porcellanous, etc.) and color. "According to my views, one must consider shells, so to say, from a mineralogical point of view." Having thus chosen conchological characters heretofore neglected, in grouping the genera and families, the discrepancies between a natural classification of the shells and one founded on dentition, according to Prof. Mörch, will disappear. "I have united in the family Tritonidæ, according to the sculpture, Ranella, Triton, Pyrula (Ficus), Dolium, Cassidaria and Cassis, placing them near to Cypræa." This is in accord with the character of their dentition, which widely removes Triton and Ranella from the Muricidæ, close to which they have heretofore been placed, upon conchological characters—principally the form of the shell, the presence of varices, the operculum, and also a decided resemblance of the animals.

I have carefully re-examined these genera and their relationships with others, in the point of view taken by Prof. Mörch, and the result of this examination is to convince me that he has selected in the sculpture a character that is of generic importance only in the single genus Dolium—that is to say, its species happen to possess revolving ribs; and even in sculpture the relationship of Triton and Ranella with Murex is exceedingly close, whilst they have little or no affinity with Dolium, Cassis, etc. In fact, it is precisely because Prof. Mörch has regarded lingual dentition *à priori* as an "infallible criterion" that he has been enabled to detect supporting resemblances in the shells. It is easy to show in many other instances, as in the group under discussion, how heterogeneous is the assemblage united by means of the "infallible criterion." There is, besides, a growing conviction, that there are no sharply-defined groups in nature; that a generic character, for example, cannot be made to cover all its species; that upon its borders occur forms which partake of the characters of other so-called genera, and that families, orders, etc.,

similarly coalesce upon their confines. We may anticipate a period when our larger collections, together with our better knowledge of external influences and of the power of adaptation to them of these creatures, shall reveal to us a series of recent and fossil forms having relationships so intimate, that our present system of classification and resulting nomenclature shall become utterly valueless.

In this point of view classification is essentially arbitrary and we can only help ourselves by choosing that which does least violence to natural affinities. The value of a classification founded on a single organ (the lingual ribbon), which does violence to other apparent affinities, whilst at the same time it fails of signification even in one of the most important functions with which it is connected, in that it does not enable us to certainly separate the phytophagous from the zoophagous animals, may be seriously questioned. We have many most important characters of the mollusks which impress themselves upon their shells, so that they are in accord and enable us to predicate reciprocally their relationships; and such characters appear to me to be much more useful for classification.

Mr. Wm. G. Binney, who has devoted a number of years to the study of the dentition and anatomy of terrestrial mollusks, has recently given the following guarded opinion upon the value of the jaw and lingual membrane for the purpose of classification.

"It is conceded by all recent students of land shells that for the larger divisions the presence or absence of a jaw and the aculeate or quadrate form of marginal teeth are reliable characters.

"The characters of the jaw and separate teeth of the lingual membrane have also been used in various ways for grouping the genera into families, etc., and even of grouping species into genera. I refrain from any discussion of their value for such purposes, simply because I believe our material is far too limited. It seems as if I can better employ my time in patiently accumulating new facts. I can, however, venture to say that the character of the jaw and teeth seems to be more constant in some genera than in others. It appears, for instance, that in some genera the presence or absence of lateral teeth is not a generic character, though in others it is. The same may be said of the presence or absence of side-cutting points to the centrals and laterals, and the greater or less development of their side cusps; also in the bifurcation or non-bifurcation of the cutting point of aculeate marginal teeth; also as to the presence or absence of ribs on the jaw.

"It will, I believe, be proved that certain genera are constantly characterized by a peculiar form of teeth, while others have a considerable range of variation. I might, perhaps, add that when the genus is numerous in species, there is a much greater

chance of finding a varying dentition. If this latter proves true, we shall be obliged to concede that there are certain types of teeth which may be found among the species of some of the larger genera, though some of the smaller genera are much more, if not absolutely restricted to one single type of dentition."

If it be proposed that a single arbitrary standard shall be used because it *is* arbitrary and hence will remove all doubt as to the position of a given species, then the standard selected should be the most universal and the most apparent—namely, the shell. But if a *natural* arrangement be attempted, still less can we make account of any character which is not in accord with the assemblage of characters. A natural sequence can only result from an accordance of most of the organs and functions. That dentition in the mollusks is a character worthy of study, that it will throw light on many doubtful points, that it will correct many errors is not to be disputed; but the claims made for it are preposterous;—for whilst a few hundred species only have had their tongues examined, described and figured, many thousands have been arbitrarily placed and displaced in consequence. Stimpson has examined the tongue of *Ranella caudata* and finds it to be that of a Murex; accordingly he separates from Ranella a few other species *because their shells resemble the shell of Ranella caudata* and unites them also with Muricidæ and this is practically the course (and necessarily so) pursued by all these dentition systematists. If conchological characters may be used to support the fabric reared upon the knowledge (I had almost written the want of knowledge) of a single structural character, why may they not be equally used against it. Is it not impertinent to make use of a few hundred observations of an organ which only pervades a portion of the mollusca, to establish a classification which is frequently in violent contrast with natural affinities ascertained by long examination of all the species, recent and fossil?

If the exo-skeleton or shell carries the impress of its animal, its right appreciation will afford us the *only possible* classification. It is not partial, but pervades nearly the whole mollusca—as well those which have no lingual ribbon: its universality is the proof of its higher systematic importance: its relationships are not single, it is the epitome of the modifications of molluscan structure. Supposing the dentition of all living forms to be examined (an impossibility), we are still confronted by the fossil shells, which absolutely refuse to be classified by any other than conchological characters. What shall we do with them? Shall we use for these 30,000 species obvious external, universal characters, yet discard these in the recent mollusca for the modifications of a partial character, the very slight observation of which has sufficed to show that it may not be predicated with

certainty from either the shell, operculum, external features, or anatomy of the animal?

Whilst I shall continue to find in the shell the usual characters for the discrimination of genera and families, I shall not refuse all the aid which I can obtain from the study of lingual dentition as well as from all other sources which may enable me to more rightly appreciate natural relationships, to correct error, to avoid it. For the present, I prefer to treat Triton and Ranella as transitional genera having many relationships with the Murices, but partaking in their dentition and in some other structural details in the characters of Cassis, Dolium, etc.

Prof. Theodore Gill published in 1871, under the auspices of the Smithsonian Institution an "Arrangement of the families of Mollusks," largely founded on their lingual dentition. Whilst this classification presents many features as novel as praiseworthy, reflecting the highest credit on the philosophical views and critical acumen of its author, it is, I think, equally unacceptable with those classifications heretofore proposed by European authors in which this character has been used as an exclusive guide. I reproduce Prof. Gill's arrangement:—

Arrangement of Families of Mollusks.

BY PROF. THEODORE GILL.

(The figures in brackets refer to the illustrations of lingual dentition in *this work*.)

CLASS. A. CEPHALOPODA.

ORDER 1. DIBRANCHIATA.

Suborder Octopodia.

(*O. littorales.*)

1. Cirrhoteuthidæ. 2. Octopodidæ (x, 1).

(*O. pelagici.*)

3. Philonexidæ. 4. Argonautidæ.

Suborder Sepiophora.

(*Oigopsidæ.*)

5. Cranchiidæ (including Loligopsidæ). 6. Chiroteuthidæ.
7. Onychoteuthidæ. 8. Ommastrephidæ.

(*Myopsidæ.*)

9. Loliginidæ (x, 2). 10. Sepiolidæ. 11. Sepiidæ.
12. Belosepiidæ. 13. Spirulidæ. 14. Belopteridæ.
15. Belemnitidæ.

ORDER II. TETRABRANCHIATA.

(*Nautiloidea.*)

16. Nothoceratidæ.
17. Bathmoceratidæ.
18. Trochoceratidæ.
19. Nautilidæ (x, 3, 4).
20. Hercoceratidæ.
21. Gyroceratidæ.
22. Lituitidæ.
23. Phragmoceratidæ.
24. Gomphoceratidæ.
25. Cyrtoceratidæ.
26. Orthoceratidæ.
27. Ascoceratidæ.

(*Goniatitoidea.*)

28. Clymeniidæ.
29. Coniatitidæ.
30. Bactritidæ.

(*Ammonitoidea.*)

31. Turrilitidæ.
32. Ceratitidæ.
33. Ammonitidæ.
34. Scaphitidæ.
35. Cryoceratidæ.
36. Ancyloceratidæ
37. Hamitidæ.
38. Ptychoceratidæ.
39. Hamulinidæ.
40. Toxoceratidæ.
41. Baculitidæ.
42. Baculinidæ.

CLASS B. GASTROPODA.

Subclass Diœcia.

ORDER III. PECTINIBRANCHIATA.

Suborder Toxoglossa.

43. Conidæ (x, 5).
44. Pleurotomidæ.
45. Melatomidæ.
46. Haliidæ.
47. Terebridæ.
48. Cancellariidæ.
49. Admetidæ.

Suborder Rhachiglossa.

50. Cystiscidæ.
51. Marginellidæ (x, 6).
52. Volutidæ (x, 7).

(*Odontoglossa.*)

53. Fasciolaridæ (x, 8).
54. Mitridæ (x, 9).

(*Duplohamata.*)

55. Melongenidæ (x, 18).
56. Buccinidæ (x, 11, 12).
57. Nassidæ (x, 13).
58. Cynodontidæ (x, 10).
59. Turbinellidæ (x, 14).

(*Hamiglossa.*)

60. Turridæ.
61. Olividæ (x, 15):
62. Harpidæ (x, 16).
63. Ptychatractidæ.
64. Muricidæ (x, 17, 19).
65. Columbellidæ (x, 20).

Suborder Tænioglossa.

(*Group Rostrifera.*)

66. Pomatiidæ.
67. Cyclostomidæ (xi, 21).
68. Cyclophoridæ.
69. Pupinidæ.
70. Aciculidæ.
71. Truncatellidæ.
72. Ampullaridæ (xi, 22, 23).
73. Valvatidæ (xi, 24.)

74. Viviparidæ (xi, 25).
75. Assiminiidæ.
76. Rissoellidæ.
77. Pomatiopsidæ.
78. Rissoidæ.
79. Skeneidæ.
80. Bythiniidæ.
81. Fossaridæ.
82. Littorinidæ (xi, 26).
83. Pyramidellidæ.
84. Eulimidæ.
85. Styliferidæ.
86. Ceriphasiidæ (Strepomatidæ, xi, 27).
87. Melanopidæ.
88. Melaniidæ.
89. Cerithiopsidæ.
90. Cerithiidæ.
91. Planaxidæ.
92. Cæcidæ.
93. Vermetidæ.
94. Tenagodidæ.
95. Turritellidæ.
96. Trichotropidæ.
97. Hipponicidæ.
98. Capulidæ.
99. Calyptræidæ.
100. Neritopsidæ.
101. Onustidæ.
102. Strombidæ (xi, 28).
103. Aporrhaidæ.

(*Digitiglossa.*.)

104. Pedicularidæ (xi, 29).
105. Amphiperasidæ.

Rostrum with invertible tip.

106. Cypræidæ (xi, 30).
107. Triviidæ (including Eratoinæ).
108. Marseniidæ.
109. Velutinidæ.
110. Naticidæ (xi, 31).

Group Proboscidifera.

111. Pyrulidæ.
112. Doliidæ (xi, 32).
113. Cassididæ.
114. Ranellidæ.
115. Tritonidæ (xi, 33).

Suborder Ptenoglossa.

116. Ianthinidæ (xi, 35).
117. Solariidæ (xii, 39, 40).
118. Scalariidæ (xi, 36-38).

ORDER IV. HETEROPODA.

119. Atlantidæ (xii, 41).
120. Carinariidæ (xii, 42.)
121. Pterotrachæidæ.

ORDER V. RHIPHIDOGLOSSA.

Suborder Podophthalma.

122. Hydrocænidæ.
123. Stoastomidæ.
124. Helicinidæ (xii, 43).
125. Proserpinidæ.
126. Neritidæ (xii, 44, 45.)
127. Rotellidæ.
128. Turbinidæ (xii, 47.)
129. Liotiidæ.
130. Trochidæ (xii, 46.)
131. Stomatellidæ.
132. Pleurotomariidæ.
133. Scissurellidæ.
134. Haliotidæ.
135. Maclureidæ.

Suborder Dicranobranchia.

136. Fissurellidæ.
137. Emarginulidæ (xii, 50).
138. Bellerophontidæ.

ORDER VI. DOCOGLOSSA.

Suborder Proteobranchia.

139. Acmæidæ. 140. Patellidæ (xii, 51.)

Suborder Abranchia.

141. Lepetidæ.

ORDER VII. POLYPLACOPHORA.

142. Chitonidæ (xii, 52). 143. Chitonellidæ.

Subclass Pulmonifera.

ORDER VIII. PULMONATA.

Suborder Geophila.

(*Oculiferous tentacles invertible.*)

(*Agnatha.*)

144. Oleacinidæ (xiii, 56). 145. Streptaxidæ.
146. Testacellidæ.

(*Goniognatha.*)

147. Orthalicidæ (xiii, 58).

(*Holognatha.*)

148. Cylindrellidæ. 149. Pupidæ.
150. Helicidæ (xiii, 59). 151. Vitrinidæ.

(*Togata.*

152. Philomycidæ.

(*Subnuda.*)

153. Cryptellidæ. 154. Parmacellidæ.
155. Limacidæ (xiii, 61). 156. Arionidæ.

(*Elasmognatha.*)

157. Succinidæ (xiii, 63). 158. Janellidæ.

(*Oculiferous tentacles simply contractile.*)

159. Vaginulidæ. 160. Onchidiidæ.

Suborder Basommatophora.

(*Limnophila.*

161. Chilinidæ. 162. Physidæ.
163. Ancylidæ. 164. Limnæidæ (xiii, 64–65).
165. Otinidæ. 166. Auriculidæ (xiii, 67).

(*Petrophila.*)

167. Siphonariidæ. 168. Gadiniidæ.

(*Thalassophila.*)

169. Amphibolidæ.

Subclass Opisthobranchiata.

ORDER IX. TECTIBRANCHIATA.

170. Philinidæ.
171. Amphyspiridæ.
172. Ringiculidæ.
173. Actæonidæ.
174. Actæonellidæ (xiii, 68).
175. Cylichnidæ.
176. Bullidæ.
177. Aplustridæ.
178. Lophocercidæ.
179. Aplysiidæ.
180. Runcinidæ (xiii, 70).
181. Tylodinidæ.
182. Umbrellidæ.
183. Pleurobranchidæ.

ORDER X. NUDIBRANCHIATA.

Suborder Pygobranchia.

184. Doridopsidæ.
185. Dorididæ (xiii, 69).
186. Onchidorididæ.
187. Goniodorididæ.
188. Polyceridæ.
189. Triopidæ.
190. Ceratosomidæ.

Suborder Polybranchia.

(*Inferobranchia.*)

191. Phyllidiidæ.
192. Diphyllidiidæ.

(*Polybranchia.*)

193. Tritonidæ.
194. Scyllæidæ.

(*Ceratobranchia.*)

195. Dendronotidæ.
196. Heroidæ.
197. Tethyidæ.
198. Dotoidæ.
199. Protonoctidæ.
200. Glaucidæ.
201. Eolididæ.
202. Fionidæ.
203. Hermæidæ.

Suborder Pellibranchiata.

204. Elysiidæ.
205. Limapontiidæ.
206. Phyllirrhoidæ.

Suborder Entoconchacea.

207. Entoconchidæ.

Subclass Pteropoda.

ORDER XI. THECOSOMATA.

208. Limacinidæ.
209. Hyalidæ (xii, 55).
210. Cymbuliidæ.
211. Conulariidæ.
212. Hyolithidæ.

ORDER XII. GYMNOSOMATA.

214. Clionidæ.
215. Pneumodermonidæ (xii, 53–54).
216. Cymodoceidæ.

Subclass Prosopocephala.

ORDER XIII. SOLENOCONCHÆ.

217. Dentaliidæ.

CLASS C. CONCHIFERA.

ORDER XIV. DIMYARIA.

(*Pholadacea.*)

218. Aspergillidæ. 219. Gastrochænidæ.
220. Teredinidæ. 221. Pholadidæ.

(*Solenacea.*)

222. Solenidæ. 223. Solecurtidæ.

(*Myacea.*)

224. Saxicavidæ. 225. Myidæ.
226. Corbulidæ. 227. Pandoridæ.
228. Anatinidæ. 229. Myochamidæ.
230. Pholadomyidæ.

(*Veneracea.*)

231. Mactridæ. 232. Mesodesmidæ.
233. Amphidesmidæ. 234. Tellinidæ.
235. Psammobiidæ. 236. Donacidæ.
237. Petricolidæ. 238. Veneridæ.
239. Glauconomidæ.

(*Corbiculacea.*)

240. Cyrenidæ. 241. Pisidiidæ. 242. Cyrenoididæ.

(*Dreissenacea.*)

243. Dreissenidæ.

(*Cardiacea.*)

244. Veniliidæ. 245. Glossidæ.
246. Cardiidæ. 247. Adacnidæ.

(*Chamacea.*)

248. Chamidæ.

(*Lucinacea.*)

249. Lucinidæ. 250. Ungulinidæ. 251. Erycinidæ.
252. Cyamiidæ. 253. Leptonidæ. 254. Galeommidæ.

(*Solemyacea.*)

255. Solemyidæ.

(*Carditacea.*)

256. Crassatellidæ. 257. Carditidæ.

(*Naiades.*)

258. Unionidæ. 259. Iridinidæ. 260. Mycetopodidæ.

(*Muelleracea.*)

261. Ætheriidæ. 262. Muelleriidæ.

(*Trigoniacea.*)

263. Trigonidæ.

(*Arcacea.*)

264. Nuculidæ. 265. Ledidæ. 266. Arcidæ.

ORDER XV. METARRHIPTÆ.

267. Tridacnidæ.

ORDER XVI. HETEROMYARIA.

268. Mytilidæ.

ORDER XVII. MONOMYARIA.

(*Aviculacea.*)

269. Pinnidæ. 270. Pteriidæ. 271. Vulsellidæ.

(*Pectinacea.*)

272. Spondylidæ. 273. Limidæ. 274. Pectinidæ.

(*Anomiacea.*)

275. Placunidæ. 276. Anomiidæ.

(*Ostracea.*)

277. Ostreidæ. 278. Eligmidæ.

ORDER XVIII. RUDISTA.

279. Hippuritidæ. 280. Radiolitidæ.
281. Caprinellidæ. 282. Caprinidæ.
283. Caprotinidæ.

Subbranch Molluscoidea.

CLASS D. TUNICATA.

(Families 284 to 298 inclusive.)

CLASS E. BRACHIOPODA.

ORDER XXIII. ARTHROPOMATA.

(*Ancylopoda.*)

299. Terebratulidæ. 300. Thecidiidæ.

(*Helictopoda.*)

301. Spiriferidæ. 302. Atrypidæ.
303. Koninckinidæ. 304. Rhynchonellidæ.
305. Strophomenidæ. 306. Productidæ.

ORDER XXIV. LYOPOMATA.

307. Craniidæ. 308. Discinidæ. 309. Lingulidæ.

CLASS F. POLYZOA.

(Families 310 to 356 inclusive.)

I propose to follow in this work a classification which does not differ very essentially from that most approved before the advent of the lingual system, but with certain ameliorations which the latter has enabled us to perceive for the first time. It is not denied that this arrangement is exceedingly artificial—all are so; but it is believed to be the most obvious, therefore, the easiest. It may again be remarked here, that one of the inherent difficulties of arrangement in a lineal line is caused by inter-relationships; thus, I have chosen to proceed from Murex to Pupura, then to Fusus and to Buccinum; yet the two latter groups are equally related to Murex and with one another, and the passage from one group to another is so gradual that the assignment of some of the out-lying forms to a genus is very difficult.

ON COLLECTING SHELLS.

Search for living mollusks is based upon knowledge of the habits of these animals. We call *stations* the particular circumstances surrounding the specimens collected, whilst *habitat* comprehends the geographical distribution of each species.

Marine Mollusks. "When the tide is at the lowest, the collector should wade among the rocks and pools near the shore, and search under overhanging ledges of rock as far as his arms can reach. An iron rake, with long close-set teeth, will be a useful implement on such occasions. He should turn over all loose stones and growing sea-weeds, taking care to protect his hands with gloves, and his feet with shoes and stockings, against the sharp spines of Echini, the back-fins of sting-fishes, and the stings of Medusæ. In detaching chitons and limpets, which are all to be sought for on rocky coasts, the spatula or case-knife will prove a valuable assistant. Those who have paid particular attention to preserving chitons have found it necessary to suffer them to die under pressure between two boards. Ormers (Haliotides) may be removed from the rocks to which they adhere by throwing a little warm water over them, and then giving them a sharp push with the foot sideways, when mere violence would be of no avail without injuring the shell. Rolled madrepores and loose fragments of rock should be turned over; cowries and other shell-fish frequently harbor under them. Numbers of shell-fish are generally to be found about coral-reefs."—(BRODERIP.) In coral regions the services of natives should be obtained, as they may render much assistance by diving or wading.

Advantage may be taken of spring-tides, especially at the equinoxes, to examine lower tracts of sea-shore than are ordinarily accessible. After severe storms the shores and beaches are frequently covered with species of mollusks and other marine

animals, seldom obtained at other periods except by the dredge. Many bivalves bury in sand and mud at extreme low-water, and may be obtained alive by digging with a spade or fork; others may be found boring in piles and rocks, and require the hammer and chisel for their extraction. Bivalves may be boiled, and their soft parts removed when the shells gape. Care should be taken not to injure the ligament, or hinge, especially in the genera (like the Anatinidæ) provided with an ossicle.

Mr. Joshua Alder remarks that "in collecting among rocks the principal thing is to look close, particularly in crevices and under stones. Minute species inhabiting sea-weed are best obtained by gathering the weed and immersing it for some time in a basin of sea-water, when the little mollusks will generally creep out. If the shells only are wanted, the surer and more ready way is to plunge the weed into fresh-water, when the animals immediately fall to the bottom." Sea-fishes and fowl purchased for the table should be carefully examined when opened for cleaning; shells are frequently obtained in this way:—which has furnished conchologists with many fine specimens.

The floating mollusca of the open sea, especially in tropical latitudes, are comparatively little known. Good drawings, and descriptions made from the life, are most valuable. "Of the animal of the Spirula, entire specimens are still greatly wanted. If captured alive its movements should be watched in a vessel of sea-water, to see whether it has the power of rising and sinking at will; its mode of swimming, and position during these movements, and when at rest. The chambered shell should be opened under water, to ascertain if it contain a gas, the nature of which should, if possible, be made out. The pearly nautilus requires the same observations, which would be attended with more precision and facility from its larger size."—(Owen.)

The towing-net used by Mr. McGillivray "consisted of a bag of bunting (used for flags) 2 feet deep, the mouth of which was sewn round a wooden hoop 14 inches in diameter; three pieces of cord, 1½ foot long, were secured to the hoop at equal intervals and had their ends tied together. When in use, the net was towed astern, clear of the ship's wake, by a stout cord secured to one of the quarter-boats, or held in the hand. The scope of the line required was regulated by the speed of the vessel at the time, and the amount of strain caused by the partially submerged net."—Voy. Rattlesnake.

A trawl-net for use on sea-bottoms is thus constructed: The side frames are of iron, the upper beam of wood, and the lower edge of the net is kept down to the ground by means of a chain, which is wolded or wrapped round with old rope. The beam is generally from 40 to 50 feet in length, and about 8 inches square. The net is about 30 yards in depth, and has a couple of pockets

inside. The end is untied when the net is hauled on board for the purpose of taking the fish out. These nets can only be worked where the bottom of the sea is free from rocks. They are used by boats of 35 to 60 tons, manned by crews of from four to six men and two to three or four boys. In the vicinity of Scarborough, England, they fish with these nets between the shore-reefs and the off rock, which is 4 to 10 miles from land; the bottom is sand or clay, with 4 to 15 fathoms water on the land side, and 17 to 25 fathoms on the off side. Immense quantities of crustacea and shell-fish are taken with the trawl, as well as ground-fish.

Kettle-nets. On the flat, sandy coast of Kent and Sussex, England, mackerel-fishery is pursued by setting up stakes 10 or 15 feet high, at distances of 10 feet apart, in lines running outwards from the shore at high-water, to low-water neap tides, where they are turned in the direction of the tide. To these stakes nets are attached, and leaded, which remain as long as the fish are on the coast. Cuttle-fish are frequently taken in these nets.

Deep-sea Fishery. In North Britain an extensive ground-fishery is conducted by means of long lines—often a mile in length—with hooks and baits every few yards. These lines are laid out at night near the coast, and taken up the next morning. When used out at sea, the boats lay by for a few hours, and then take up the lines. The carnivorous whelks adhere to the baits (which have not been seized by fishes), and sometimes a bushel of them are taken in this way from a single line. *Rhynchonella psittacea*, *Panopæa Norvegica*, Velutinæ and some of the scarce Fusi, have been obtained from these lines, the bivalves having been entangled accidentally by the hooks.

For trapping whelks on rocky ground a net may be made such as is used for crabs and lobsters, by attaching a loose bag to an iron ring of a yard across. This is fastened to a rope by three equal strings, baited with dead fish, and let down from a vessel at anchor, or, still better, from a buoy. It is put down over night, and hauled up gently in the morning.

Carnivorous mollusks are often found in lobster-pots, which they enter to feed upon the bait.

Dredging. "Up to the middle of last century the little that was known of the inhabitants of the bottom of the sea beyond low-water mark, seems to have been gathered almost entirely from the few objects found thrown upon the beach from time to time after storms, and from chance captures on lead-lines, and by fishermen on their long-lines and in trawls and oyster and clam dredges.

"The naturalist's dredge does not appear to have been systematically used for investigating the fauna of the bottom of

the sea, until it was employed by O. F. Müller in the researches which afforded material for the publication in 1799, of his admirable 'Descriptions and History of the Rarer and Less-known Animals of Denmark and Norway.' In the preface of the first volume Müller gives a quaint account of his machinery and mode of working which it is pleasant to read.

"The instrument usually employed for dredging oysters and clams is a light frame of iron about five feet long, by a foot or so in width at the mouth, with a scraper like a narrow hoe on one side, and a suspending apparatus of thin iron bars which meet in an iron ring for the attachment of the dredge rope on the other. From the frame is suspended a bag about two feet in depth, iron chain netting, or of wide-meshed hempen cord netting, or of a mixture of both.

"Naturalist dredgers first used the oyster dredge, and all the different dredges now in use are modifications of it in one direction or another; for in its simplicity it is not suitable for scientific purposes. The oyster dredge has a scraper only on one side. In the skilled hands of the fishermen this is no disadvantage, for it is always sent down in such a way that it falls face foremost; but philosophers using it in deep water very generally found that whether from clumsiness or from want of sufficient practice, they had got the dredge down on its back and of course it came up empty. Again oyster dredgers are only allowed to take oysters of a certain size, and the meshing of the commercial dredge is so contrived as to allow all bodies under a certain considerable size to pass through. This defeats the object of the naturalist, for some of the prizes to which he attaches the highest value are mites of things scarcely visible to the unaided eye.

"The remedy for these defects is to have a scraper on each side, with the arms attached in such a way that one or the other of the scrapers must reach the ground in whatever position the dredge may fall; and to have the bag deeper in proportion to the size of the frame, and of a material which is only sufficiently open to allow the water to pass freely through, with the openings so distributed as to leave a part of the bag close enough to bring up the finest mud.

"The late Dr. Robert Ball, of Dublin, devised the modification which has since been used almost universally by naturalists under the name of "Ball's Dredge." The dredges on this pattern used in Great Britain for ten years after their first introduction about the year 1838, were usually small and rather heavy—not more than from twelve to fifteen inches in length by four to five and a half inches in width at the mouth. There were two scrapers the length of the dredge-frame and an inch and a half or two inches wide, set at about an angle of 110° to

by the scraper passing over the irregularities of the bottom. The due amount of rope is then paid out, and the rope hitched to a bench or pollock-pin.

"When there is anything of a current, from whatever cause, it is usually convenient to attach a weight varying from fourteen pounds to half a hundred-weight, to the rope three or four fathoms in front of the dredge; this prevents, in some degree, the lifting of the mouth of the dredge. If the weight be attached nearer the dredge, it is apt to injure the delicate objects passing in.

"The boat should move very slowly, probably not faster than a mile an hour. In still water, or with a very slight current, the dredge of course anchors the boat, and oars or sails are necessary; but if the boat be moving at all it is all that is required. I like best to dredge with a close-reefed sail before a light wind, with weights, against a very slight tide or current; but these are conditions which cannot always be commanded. The dredge may remain down from a quarter of an hour to twenty minutes, by which time, if all things go well, it ought to be fairly filled.

"In dredging from a small boat the simplest plan is for two or three men to haul in, hand over hand and coil in the bottom of the boat. For a large yawl or yacht, and for depths beyond fifty fathoms, a winch is a great assistance. The rope takes a couple of turns round the winch, which is worked by two men, while a third takes it from the winch and coils it.

"Dredging in deep water—that is, at depths beyond 200 fathoms—is a matter of some difficulty, and can scarcely be compassed with the ordinary machinery at the disposal of amateurs. Deep-sea dredging can no doubt be carried on from a good-sized steam yacht, but the appliances are so numerous and so bulky, and the work is so really hard, that it is scarcely compatible with pleasure-seeking."—WYVILLE THOMSON, "The Depths of the Sea."

In the valuable and interesting work above quoted (p. 246), may be found a full description, with figures, of the apparatus used in deep-sea dredging by the *Porcupine*. That vessel, on July 20th, 1870, dredged no less than 186 species of mollusks at a single haul, off the coast of Portugal, and from the great depth of 994 fathoms. Nearly forty per cent. of these were of undescribed species! "This remarkable collection," says Wyville Thomson, "of which not much more than one-half is known to conchologists, notwithstanding their assiduous labors, teaches us how much remains to be done before we can assume that the record of marine zoology is complete. Let us compare the vast expanse of the sea-bed in the North Atlantic with that small fringe of the coast on both sides of it which has yet been partially explored, and consider with reference to the dredging last-

mentioned what are the prospects of our ever becoming acquainted with all the inhabitants of the deep throughout the globe!!"

Equally important results, have attended the more recent dredging operations of the United States Fish Commission's *Fish Hawk*, southeast of Rhode Island, adding several hundred species to our fauna.

The reader of these pages, if possessed of a salt-water aquarium, is earnestly recommended to study marine mollusks in the living state. A judicious observer will not only derive much pleasure thereby, but may also contribute to our knowledge of the habits of these interesting animals. But few of the species have been intelligently studied in this manner, and it is almost certain that very much is to be learned by the use of this method of investigation.

Land and Fresh-water Shells. The following directions for collecting and preserving these, are principally compiled from papers by Prof. A. G. Wetherby (Jour. Cincin. Soc. Nat. Hist.), and Dr. James Lewis (Smithsonian Report, 1866).

Before the collector can enter the field with much certainty as to the anticipated result of his labors, it may be necessary for him to satisfy himself that there are in the district about him shells enough to offer encouragement. It will be found generally, that those sections of the country that have a dry sandy soil are unfavorable to the production of mollusks. Regions in which pines abound are proverbially of this character, and here the efforts of the collector are usually but indifferently rewarded. In the moist alluvial soil of limestone formations are found the most favorable conditions for the production of mollusks. This is more notably true with regard to land shells; aquatic species are also affected similarly, but less conspicuously, by the character of the soil. But it will almost invariably be observed that waters deficient in lime do not produce shells as perfect nor in as great numbers as waters charged with that earth.

Land Shells. With a few exceptions, relating to some of the smaller species and also a few species of semiaquatic habits, the land shells of this country are found most abundantly in the wooded alluvial regions, especially upon hill-sides having a northern exposure; where, during the day they are concealed under fragments of fallen trees, bits of bark, chips, etc., sometimes under leaves or in the tufts of rank growths of moss. Some species will be occasionally found in the moist debris of shaly rocks in ravines. Species peculiar to the Southern States are sometimes met with on shrubs and trees. Some species of semiaquatic habits, though occasionally seen on the rank vegetation along rivers (sometimes several feet from the ground), are more frequently observed under bits of wood, leaves, etc., near the muddy slopes of streams or ponds, or in the vicinity of

water, where they may find concealment either in grass or under the shade of aquatic plants.

Among our most minute species are those that delight in wet grass lands, or in localities that are usually moist during a very considerable portion of the year. They are sometimes found in such localities congregated in hundreds under stray fragments of boards, bits of wood, etc.

As different sections of the country offer constantly varying conditions affecting the habits of land shells, it may be expected that some species that usually are found in such stations as have just been indicated may in exceptional instances be found under circumstances where the collector might least hope to discover them. It accordingly becomes the collector to be at all times on the alert, and to inspect every kind of station. By doing so, he will often unexpectedly discover desirable species and acquire information respecting their habits, of more value to him than any suggestions that might be conveyed to him by a volume of printed instructions.

As examples it may be stated that in and around dilapidated buildings, where fragments of brick and mortar cover the ground, large numbers of the smaller species of Helix, Pupa, Carychium, etc., will be found. They adhere to the under surface of a piece of porous brick in preference to a fragment of gneiss, limestone or other rock. Also the cavity of a decayed tree or stump, when examined in the early days of spring, will reward the searcher abundantly. Rich harvest may also be frequently gathered by laying boards upon the grass or ground, wetting them previously unless immediately after a rain. In taking them up after a night's exposure large numbers of shells will often be attached to the under surface.

Fresh-water Shells. While searching for those species of land shells that are found usually near water, the collector will often have his attention drawn to air-breathing mollusks that are properly designated aquatic mollusca. The habits of some species of this class are such that by one unacquainted with them they might be confounded with land-shells. Many of these species have a habit of crawling out of the water, remaining on the moist mud without any inconvenience. They will also sometimes be found on the stems and leaves of aquatic plants, or on other projecting substances several inches from the surface of the water. In their habits as a class they are adapted to a wide range of conditions, so that they will be found in lakes, ponds, rivers, canals, ditches, stagnant pools, swamps, and small rivulets, though some species appear to be adapted to a narrow range of conditions; the class, however, has its representatives over the whole continent. Though by far the greater number of species of mollusca belonging to this class prefer shallow water, feeding

on the vegetation that abounds in such stations, there are a few exceptions, in which species are found adapted to deep water, in which it is improbable that they can reach the surface and respire the air. The collector will find many species accessible to him along the margins of water. Others will require the aid of a boat, especially such as are found feeding on the weeds in lakes and rivers. To discover some of the minute species found under such circumstances, it may sometimes be advantageous to gather handsful of the weed and gently lift them out of the water. If the operation be rudely performed, the mollusks may be disturbed so as to detach themselves. Many species will be found adhering to the grass-like plants that grow in streams. Others adhere to the stems of flags and bullrushes, and may be discovered very readily by pulling up the plants by the roots, taking care to perform the operation gently and deliberately. Of analogous habits with some of the above are certain small species found concealed under stones just below low-water mark in rivers. They are sometimes also found adhering to larger shells. This class embraces only small cup-like shells—"fresh-water limpets" or Ancylus.

Aside from the air-breathing aquatic mollusca, we have others whose respiration is strictly aquatic; the necessities of these restrict them to a narrower range. Hence they are not usually found in stagnant waters, certainly not in waters of limited area, where impurities are generated by decomposing substances. The largest shells of this class are found in the swamps along the rivers of some of the Southern States, and are objects of interest on account of their habits as well as of their value in the cabinet. In their season of active life they are found feeding on aquatic plants. Inhabiting localities subject to drying, they burrow in the mud as the water diminishes. The collector will for convenience seek them when they are active. Another class (Viviparidæ), smaller than that just mentioned, but affording a greater number of varieties and species, is more widely distributed, being found not only in the waters of the various States, but also in Canada. They inhabit rivers, lakes, ponds and canals, and when circumstances favor their habits they will be found most abundantly burrowing just beneath the surface of the soft mud near the shores; where undoubtedly they are attracted by more abundant supplies of food, and perhaps also by a more agreeable temperature. They will often be found in the muddy banks of rivers in great numbers, congregated at the margin of the water. In canals where conditions of food and temperature are very favorable, they attain a more luxuriant growth than in neighboring rivers. Some localities are remarkable for affording varieties and monstrosities. Next to this class in size is one that embraces a large number of species included in several genera and sub-

genera (Strepomatidæ). The shells vary from a turrited to a globular form, variously colored and sometimes curiously ornamented with tubercles, ridges and carinations. With a few exceptions these interesting shells are found only in rivers or perennial streams. The different genera of this class seem to be adapted to certain modifications of conditions. Some of these mollusks prefer muddy sloping river-banks, where they crawl in the comparatively still water on the surface of the mud. Others prefer the rapid current among the rocky portions of streams, where they are found adhering to the surfaces of the rocks. The habits of nearly all the mollusca of this class are such as bring them to the shallower portions of the water they inhabit. They can often be reached from the shore by the hand.

By gradual transitions these genera, with their numerous species, are followed by other and smaller genera (Amnicolidæ, etc.), some of which are of comparatively limited range; others are widely distributed over the whole country. Nearly all of them have habits in some respects similar to the preceding class, and will be found on the muddy bottom portions of rivers, lakes, etc., or feeding on aquatic plants. The small size of many of these shells renders them somewhat difficult to discover, unless the collector has expedients for securing them with ease and certainty.

Bivalve Shells. These next claim our attention, and for convenience they will be considered under two classes, though embracing several distinct genera and species. A class of shells, none of which ever attain dimensions much exceeding half an inch (Cyclades), inhabit nearly every perrennial stream having a muddy bottom; found also in stagnant waters, lakes, ponds, canals, and, indeed, in every station fitted for molluscan life. Some species inhabit stations subject to drying during a portion of the year, and careless observers have been deceived on finding them alive in their dried habitat, and have inferred they were bivalve land shells! All the shells of this class burrow just beneath the surface of the mud, and are usually found in greatest abundance near the margin of the water or where there is but little depth. This class embraces some species remarkable for their fragility, others equally remarkable for their minuteness. They are distributed over all the explored portions of the country.

Fresh-water mussels (Unionidæ.) This class of shells embraces several genera, which, on account of the great number of species contained in them will eventually be more minutely classified in subgenera. No country in the world has produced as great a variety of forms of Unionidæ as the United States. In the northeastern portion the number of species is comparatively small, but in the South and West the number of species

becomes great, and the variety and beauty discoverable in the almost endless varieties make this class one of great interest to the collector. These mollusks inhabit lakes, rivers and canals. Stagnant water is unfavorable to them. They afford abundant food for muskrat and mink, who collect piles of shells on the shore where they bring the mollusks to feed upon them. The shells left by the muskrat sometimes serve as a resort for the collector who is not critical to have the best of specimens, while they should serve to point out to him that there are good specimens, alive, not far distant. Except in shallow portions of rivers it is sometimes difficult, however, to find mussels; but where the water is not so deep but that a person may wade in it with security, it is comparatively easy to discover them. They will usually be found partly buried in the mud or gravel, only enough of the shell projecting to enable the mollusk to extend the siphons of his breathing apparatus into the water above him. A little practice will enable the collector to detect the projecting shell. In lakes and ponds, where the water is not too deep, the collector may readily discover the objects of his search from a boat.

Having thus in general terms given such suggestions as will enable the collector to seek shells understandingly, it will now be proper to speak more particularly of collecting. It may be doubted whether there is really such a thing as a "rare" species. The fable continually disappears in reference to forms once so considered. Hence intelligence and good judgment will usually enable a persevering collector to obtain a reasonable number of examples of any object to be found in his region, belonging to recent fauna and flora. The following rules of action are essential:—

1. Never rest satisfied until you have found the best examples of a species which your time and opportunities will allow.

2. Never collect imperfect or immature specimens, unless they exhibit some character making such a step desirable.

3. Having found a station which produces the finest specimens, study it carefully, that you may the more easily recognize such surroundings again.

4. If specimens are abundant collect plenty, and the work on that species will be done at once, save as you meet with desirable varieties.

5. Remember that if your specimens are good and clean, it will always give you an advantage in exchanges as soon as correspondents begin to recognize this fact. Never pick up a poor specimen with the remark, "this will do for exchange," if a good one can possibly be had.

Land Shells. The only apparatus needed in the field is the following:—One or two small bottles, 1 oz. and 2 oz., half filled

with a mixture, two-thirds best alcohol and one-third water and well corked. If these bottles are flattened oval, they may be carried in waistcoat-pockets, and will always be convenient of access.

A pair of dissecting forceps, of medium size. These will be found useful in picking up loose small shells, in taking them from crevices in bark, old logs, etc. The point of a pen-knife answers equally well if skilfully handled. This is a "knack" to be acquired by practice.

Two or three flattish boxes, of different sizes, that will readily slip in and out of the coat-pockets.

A rake made as follows: Having a head made of good oak or hickory, about nine inches long, and one inch by one and a half inches. In the centre make an oval hole for the handle, one inch long and one-half an inch or more wide. Put two blunt teeth, each two and a half inches long, exclusive of the part in the head, on each side of the handle, so placing the holes bored to receive them as to make the space between the teeth equal. Make the teeth of the toughest seasoned hickory. Make of the same material, a smooth, straight handle, twenty inches long, with one end exactly fitted to the hole in the head. This end should project through the head at least three-fourths of an inch. It should be bound by a narrow ferrule, so set into the wood as to permit the handle to slip into the head readily. A hole for a small steel spring-key should be made between the ferrule and the rake-head, and so close to each that the key, when in place, shall rest against the ferrule on one side and the rake-head on the other. When not in use the rake can be taken apart by withdrawing the key, and the whole implement can be carried in the coat-pockets. This instrument is indispensable; with it a hill-side may be rapidly raked over, or any other ground inhabited by land-shells, and, if the hands are covered by buck-skin gloves, briar-patches and other forbidding localities may be explored, and they are often very productive. As much surface can be worked over, with this implement, in half an hour, with perfect comfort and cleanliness, and without injury to the hands, as in half a day using the fingers only, and regions can be examined that it would be impossible to explore without it.

A small tool, made like a hatchet, with a narrow blade at one end, and somewhat hooked and pointed at the other, after the fashion of a geologist's pick, is very convenient for picking and hacking in pieces old logs, cutting away brush, pulling over stones, etc. No other tools are necessary or even desirable.

Being provided with these implements, you have only to sally forth, and with perseverance you will succeed in finding whatever a given locality is likely to produce. Having found the specimens, transfer all the smaller ones to the alcohol. Shells of

Stenotrema can be cleaned by removing the animal, but these and all shells below them in size, except the Succineas, should be dropped into the alcohol. Naked mollusks (snails or slugs) should be placed in a separate collecting bottle of alcohol, because of the mucus which they so plentifully shed. After death, when they have become somewhat stiffened, this mucus may be readily removed from their bodies with clean water. They are most conveniently preserved in alcohol. The larger species of land shells may be dropped, promiscuously, into the collecting boxes mentioned above. When a sufficient number of specimens has been secured, they must be cleaned and prepared for the cabinet. The following tools are necessary:

A few hooks of annealed wire, of different sizes and lengths. Take any piece of such wire, put a short, pine handle of suitable size on one end, and file the other to a somewhat slender point. These are used for drawing the snails out of their shells. They will hold better if you bend the point into a small hook.

Two or three brushes of different sizes.

A test-tube, five or six inches long, and half an inch in diameter, and a pint of perfectly clean white sand. A syringe; a rubber one, an inch diameter in the barrel, and six inches long, with a small nozzle aperture, is the best.

A small strainer, such as is used for tea or coffee; and a shallow pan, say two inches deep, and six inches in diameter.

Let us begin with the larger snails and wash every one clean. Have your pan of hot water on the stove, your unclean shells and implements all handy on a low table near by. Put two or three or half a dozen if you are tolerably sure of success, into your strainer, to which a wooden handle has been fixed. Set it with the shells into the hot water, and allow it to remain for a minute or less. Life is out, and taking one of the specimens in your left hand, between the thumb and fore-finger, hook one of your wire implements into the animal, making a gentle effort to withdraw it. If it comes out readily, draw out the others and throw them into a dish of clean, tepid water. If the animals cannot be withdrawn readily, scald them again for a short time. They will usually come out easily enough, but certain species cannot be withdrawn if scalded too much. These are matters of experience and will be learned by perseverance. Shells that you cannot at first succeed with, on account of irregularities in the aperture, small size, etc., will be mastered after awhile. Having withdrawn the animals wash the shells again thoroughly on the outside, and syringe them *thoroughly* inside, shake out the water and lay them on a newspaper to dry, mouth downward. The specimens thus prepared will be perfect, clean, and a delight either for study or exchange. The small shells remain to be looked after. If they are clean, leave them in the alcohol for a

[illegible] put your sample into [illegible] pieces and scrape (?) [illegible] When [illegible] the water, washing out [illegible] and [illegible] sticks and leaves, and [illegible] this operation until [illegible] are easily removed.

Put the little univalves into alcohol. The smaller Pisidiums and Sphæriums may also go there. The larger Sphæriums may be treated as hereafter described.

By this means if you do not hesitate to wade in the mud once in awhile, you can very rapidly collect all that you will need of such species from a given locality. The same implement can be used for skimming Planorbis, Physa and Limnæa from the surface, or for collecting them from the bottom when crawling there. These shells should be taken home in the boxes. If you are collecting in southern streams, where the various genera of the Strepomatidæ abound, no plan is so expeditious as the judicious use of the scoop. In some cases hand-picking must be resorted to, as these creatures live on the under sides of stones, in rock crevices, and among the gravel and pebbles at the bottom of streams, where they cannot otherwise be reached.

Gather these all into alcohol. It is not necessary to extract the animals; if they are taken out, dried and cleaned, as will be described, they will be in prime condition. If to the alcohol a quantity of arsenic be added, the larvæ of Dermestes and Anthrenus will not afterwards infest them. In hunting for fresh-water univalves every kind of station should be explored. In mountain regions, springs, creeks, rivulets, small ponds, and larger streams will all have their characteristic genera, species and varieties, and all need to be thoroughly worked up.

The Unionidæ may be taken with a pair of spoon-tongs, worked from a row-boat; but for these mollusks it must be admitted that no other plan is equal to wading into the water, and taking out the specimens alive from their normal stations. Species inhabit all kinds of bottom, pebbly, sandy, muddy and gravelly. Some species even prefer narrow crevices in the rocky bottoms of streams, as the *U. punctatus* in the Cumberland River, and *U. fascinans*, in Powell River. The collector who is unwilling, through fear of snakes, colds, or rheumatism, to don an old suit and "wade in," or to strip and dive if necessary, will do well to quit talking about collecting Unionidæ. In many cases they will be found packed so closely in rocky or gravelly bottoms, as to enable one to soon take out bushels of them; they are thus plentiful in the Ohio, Clinch, Holston and Tennessee Rivers.

In such cases a potato-hook, or some implement of the kind, gently crowded in among them, will rake out half a dozen at a pull. The flowing water will wash away the mud and you can select such as you need. These should be carried out on the river-bank, and cleaned before going home; but if this is not practicable, the operation may be deferred until afterward. As in the case of the land shells, wash them clean, and then drop them into a kettle or pan of boiling water. When the shells gape, and the muscles are loosened, scrape out the soft parts, thoroughly wash out the inside of the shell, and again rinse off

the outside. Let the shells stand until all moisture is dried off the outside, and then wrap them close in an old newspaper, to prevent gaping by the contraction of the ligament. Smaller ones may be nested in larger ones on long journeys, where space is desirable and must be economized. But never do so if you can avoid it. It frequently occurs that the shells of Unionidæ, Strepomatidæ, and Limnæidæ are stained with ferruginous and other matters that no amount of washing will remove. If such shells are immersed for a few moments in the oxalic acid solution, these stains will readily wash off, and a judicious use of the acid does not harm the shell in the least. If it is desirable to remove these stains from the Unionidæ, they should be dropped into the acid immediately after washing and before scalding out the animal, the presence of which prevents the acid from coming in contact with the nacre of the shell, which it will slightly dim if the shell remains in it for too long a time. It is often the case among the southern shells that these stains have so obscured the really characteristic markings of the shells as to have made it one of the chief causes of so much synonymy. If dead shells must be taken or muskrat shell-heaps explored, which is sometimes the case, a judicious use of the acetic acid will remove stains, and in many cases fairly well restore the original appearance of the nacre.

The black and dirty univalves which are so generally received in exchange, and also dirty Unionidæ, may be perfectly cleaned by a judicious use of these acids. But while they are to the careful student collector an inestimable boon, a careless or injudicious use of them will ruin every shell so treated.

Where the Strepomatidæ are collected in alcohol or any preservative solution in quantity, they may be subjected to the cleaning process whenever opportunity offers. It will generally only be necessary to immerse those having the worst stains in the acid for a few moments, and then wash and rinse them thoroughly.

In operculated species, the operculum, detached from the animal by a sharp knife, should be carefully preserved. A little cotton can be inserted into the aperture and upon this, the operculum, in its natural position, may be fixed with mucilage.

Many Uniones and univalves are much improved and given the appearance they have when in water, or when wet by rubbing them with a clean sponge, on which are a few drops of boiled linseed oil. "Woolly" shells or those with a soft epidermis may be excluded from this list.

Many of the Unionidæ also have a very highly polished epidermis, and when clean look as well dry as wet. The use of oil is a great improvement to some species, and it preserves all fresh-water shells; but it must be kept off of land species. The Anodontas and thin-shelled Unios sometimes crack when dry. This difficulty may be avoided by dipping fresh specimens into

a solution of chloride of calcium—a hygrometric salt that always retains enough moisture to remain in solution under ordinary conditions of atmosphere and temperature.

Physa, Limnæa and Planorbis must be scalded and the animals removed with the land-shell hooks, and they should afterwards be treated in the same way. If stained treat them with oxalic acid, using it judiciously, and you can clean the worst of them perfectly. Amnicola, Bythinella, Gillia, Somatogyrus, etc., small univalves almost universally stained, should be put into the test tube with the sand and a small amount of the oxalic solution, and shaken as before described for the small land shells. They can thus be rendered perfectly clean and all stains will be removed. You should not undertake to remove the animals from these small shells, as if collected in alcohol as before described, the animals will be much shrunken, and when dried will not disfigure the shell particularly. Sometimes, as in *Physa hypnorum*, the soft parts adhere rather persistently within the apical whorls. In such cases, after the shells have been scalded, take up each specimen singly with the pliers and hold the apex a few seconds against the blaze of a lamp or candle. Soon a small quantity of steam forms with a slight explosion that loosens the soft parts perfectly; a jet of water from the syringe will then remove the soft parts and rinse the shell at one operation.

Pisidium and all the smaller Sphærium are often stained, and should be put in the test tube and treated in precisely the same way. The larger species may be scalded, and the animal removed as above described for the Uniones.

In conclusion, I wish to impress upon all collectors the advantage of having good, clean, perfect specimens of whatever objects of natural history they undertake to study. If the characters are obscured by dirt, or obliterated by decay or erosion, you have no right to complain if those of better tastes in these matters, and of more industry, reject as worthless these evidences of your want of either one or both of these requisites; but if you faithfully follow the suggestions here made, there will be no complaint that you lack either.

The above remarks are intended to facilitate the work of collectors legitimately employed in the advancement of science. Wanton destruction of life will always be deprecated by the naturalist as by the moralist. Do not collect for the fun of collecting; have a purpose, and when that purpose is fulfilled, stop. Take nothing unnecessarily—not even the life of a snail.

In arranging a series of species in his cabinet the collector, if unacquainted with their names, may group his species according to those analogies and obvious resemblances that show their relations to each other. He should attach a label to each species, designating it by a number until he has opportunity to replace

the number by the specific name. The label should have upon it the locality where found, and any other facts that might be of interest to the naturalist. The numbers he attaches to his species may serve as the means of ascertaining names by correspondence. Each species should be marked, so that no confusion may arise by displacement of labels.

Should the collector find it convenient to correspond with some other person similarly engaged, or should he desire to transmit a package of shells to some friend or some public institution, a few suggestions relative to packing shells for transportation may be of use. Obtain a sufficiently strong box of suitable capacity; on the bottom should be laid a thin bed of soft hay, or some other suitable elastic material. The larger shells (if such are to form a part of the contents of the package) should form the lower tiers in packing. Each shell should be wrapped in paper, and the specimens should be so compactly stowed as not to shake about. The lighter shells should occupy the upper portion of the package, and those of a fragile nature should be protected from breakage by being enveloped in cotton and enclosed in suitable small boxes. Small paper bags or cartridges may serve to contain minute species; but a more satisfactory mode is to wrap them in cotton and put them in small paper boxes, such as may be purchased at any drug-store. Each species should be appropriately labeled, giving, in legible characters, the generic and specific name of the shell, if known, after which should be written the name of the author by whom the species was published; under this should follow the locality where found. Any vacant space at the top of the package may be filled with such light material as will serve to keep the contents from shaking about after the box is closed. The top of the box should be carefully nailed secure, and plainly addressed. Packages of light weight are usually forwarded through the mails. It should be borne in mind that in case labels containing names and localities accompany the shells, the package becomes subject to letter postage, but that a very cheap rate is secured if the specimens are accompanied by numbers only. In this case, add to the address on the package "Specimens of Natural History; no writing." The names, designating the numbers by which the specimens are distinguished, will then be included in your letter of advice to your correspondent.

Terrestrial species may be readily kept alive in fern cases, supplying them with sufficient moisture and succulent food; cabbage or lettuce leaves are generally preferred by the phytophagous species. In this manner, the author of these pages has kept the larger exotic species as well as our own mollusks, sometimes for many months, with full opportunity to observe their habits, including copulation, ovipositing, the growth of the young mollusk, etc.

The great contractibility of pulmoniferous mollusks at the moment of death presents an obstacle to anatomical researches. The real position of the organs becomes difficult to recognize, and sometimes the delicate parts become injured; as the dart, for example, broken and fixed in the liver or in other glands.

On placing these mollusks in a vessel of water, closed and deprived of air, the exterior organs will be developed, as the tentacles and the foot; among others, the jaw becomes protruded; and upon adding a little tobacco the verge is plainly protruded and may be recognized. Limaces confined dry in a morsel of tobacco leaf die very quickly, their jaws and verges extruded.

Clausilias may be treated by covering the aperture of the shell with wax, through which a hole may be pricked, large enough to permit the passage of the animal, but too small to permit its retraction after its tissues have become swollen by water; in this way preparations can be made in which the jaws are thrust out and the tentacles extended.—MÖRCH.

Naked mollusks may be mounted dry by preserving them in a saturated solution of sal ammoniac and corrosive sublimate. To prepare this solution, mix in water ten parts of the former to one of the latter; and since corrosive sublimate does not easily dissolve in water, it may be previously mixed with alcohol. Cuttle-fish, snails, etc., may be prepared with this mixture, which will gradually harden them, whilst they retain both form and color. The length of time that they should remain in the solution will vary according to the size of the object and the density of its tissues. The only objection to this preparation is its poisonous character.

Naked mollusks may be preserved wet in a solution of one part of alum to ten parts of water, in which they will retain their colors better than in alcohol; but no shells must be placed in this solution, on account of its acid property. Sections of spiral shells are prepared by applying the specimen to the side surface of a grindstone; they are useful to show the internal characters; and no better use of duplicates can be made than to prepare at least one longitudinal and one transverse section to illustrate each genus (i, 6, 8, 14; ii, 30; iv, 63).

Shells are usually kept in drawers of convenient size for handling, and about two inches in depth; they are thus compactly disposed and secluded from dust and light—the former injuring their appearance, the latter causing the delicate colors to fade. The few specimens too large to put in drawers may constitute a display-cabinet for exhibition under glass in either a horizontal or upright case. For effectual preservation from dust it is better to close in two rows of drawers with a pair of doors; which may have a lock for security. In the collection of the Academy of Natural Sciences of Philadelphia, the more

[illegible]

[illegible]

Helix hirsuta, Say.	
	Camden.
Chas. F. Parker.	***N. J.***

To these cards the specimens are fixed by any good paste or glue having plenty of body, care being taken that the shell has no oil on the surface, which will prevent adhesion. **The label** *may be scratched, where it is intended to affix the specimen, for the purpose of securing a better* **adhesion to the paper. A mixture of yellow wax and pitch is an excellent medium and is** *in use in the institution above named;* **it has plenty of body and is** *not attacked by insects, but requires to be melted for use. Liquid glues and pastes are more convenient, but should be poisoned with corrosive sublimate, or the appearance of your cabinet will be ruined by museum pests.* **Considering the danger** *of using a poisoned paste, it will be better to procure a glue-pot fixed above an alcohol lamp, and use the* **wax and pitch mixture.**

In mounting a series of specimens choose a label of sufficient size to display them without crowding, and attach them by such parts that when complete the species shall be exhibited in different

positions, so as to show every portion of the surface as well as all variations due to age, size, color, sculpture, etc. A separate label should be used for each locality of a species. When specimens are too small to be mounted on the card-board, they are enclosed in a glass test-tube, made without flange, and two and three-quarters inches in length; so that a cork may project from the open end sufficiently to secure a *bite* against the walls of the tray and thus prevent the tube from rolling. The smallest sized tray mentioned above is not intended for specimens: it is placed bottom-up in the collection, and to it is affixed a label like the following, containing the name of the family, subfamily, genus, subgenus or section.

Pyramidella,

Lam.

A similar label, printed on thin paper is used for specimens in alcohol, and is pasted on the upper part or neck of the bottle. The best quality of bottles with ground-glass stoppers are used to prevent the waste of alcohol by evaporation. Alcoholic specimens are best displayed in an upright case.

To return to the dried specimens: fossils, or those of light color will appear much better if care is taken to paste a dark-colored or black paper upon the label before affixing the shells. The genera are separated in the drawers by thin wooden strips, made of walnut and oiled or varnished, or of light-wood and painted. These strips made to fit tightly, also serve to hold the trays in place in case these do not fill a drawer. Each drawer should bear a label upon its face designating its contents—the section, genus or family, as the case may be.

Very common specimens, if carefully cleaned and mounted and labeled will be found quite attractive, whilst the most showy species will, on the other hand, lose nearly all interest if carelessly prepared. The best collectors value their cabinets for their *condition* quite as much as for their *contents*: and legitimately so, for whilst carefully preparing his specimens the collector learns their characters, and when so prepared they are disposed so as to reveal these characters to others.*

*For the convenience of those residing away from the larger cities, where only museum supplies may be obtained, I annex the names of the persons who furnish similar articles to the Philadelphia Academy:

Paper trays: Union Paper Box Co., Cor. 5th and Jayne Streets; Card-board labels: W. P. Kildare, Printer, 736 Sansom Street; Glass tubes: John A. Yunck, 1126 Market Street. (All of Philadelphia.)

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SYSTEMATIC

CONCHOLOGY:

AN INTRODUCTION TO THE STUDY OF THE

MOLLUSCA.

VOL. II.

BY GEORGE W. TRYON, JR.

CONSERVATOR OF THE CONCHOLOGICAL SECTION OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

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SYSTEMATIC

CONCHOLOGY.

Class CEPHALOPODA.

Head large, connected with the body by a neck, and furnished with complex, sessile or pedunculated eyes; mouth with a pair of mandibles or beaks, resembling those of a parrot, edged with fleshy lips, and surrounded by a circle of arms.

As pointed out in the structural portion of this work, the Cephalopoda are related to the vertebrata in several particulars: in the mode of segmentation of the vitellus, in their internal cartilaginous support—a simplified skeleton; in their circulation furnished with true capillaries, their blood corpuscles, their more highly developed eyes, mandibles, etc.

Differing from other mollusks by their symmetry as well as in the above details, they nevertheless present, with more or less modification, the main distinctive features common to other classes of the subkingdom Mollusca.

The Cephalopoda are essentially carnivorous; their nourishment is derived from fish, the migrations of which they follow, and from pteropod mollusca. Certain sedentary species eat crustaceans, nudibranchiate and bivalve mollusks and bryozoa. After their exclusion, the young prey upon polyps, notably on those of the family Gorgonidæ, so common on the Algerine coast, and some of which, perhaps, furnish the material necessary for the growth or solidification of the cuttle-bone. A little larger, they attack with avidity those elegant chaplets of pearls, the rainbow-hued eggs of Eolis and Doris.

The number of cephalopods of small size is exceedingly great, but they become the prey of a multitude of enemies. On the 10th Jan., 1858, the Dutch ship Vriendentrouw sailed for two hours through dead Loligos, covering the surface of the sea as far as the eye of the lookout could reach. Mr. Vrolik found in the stomach of a Hyperoodon about ten thousand mandibles of Loligo.

It is the opinion of almost all whalemen, that the sperm whale feeds wholly on squid. Capt. Daniel McKenzie, of New Bedford, says: "The smaller kind they eat is found near the surface, and is from 2 to 3 feet in length; the larger kind, which probably have their haunts deep in the sea, must be of immense size. I have seen very large junks floating on the surface entirely shapeless." Capt. Francis Post says: "Whales in the agony of death, frequently eject from their stomach pieces as large as the bulk of a barrel, and these in large quantities. Large pieces of squid are often seen floating on the sea, which whalers consider indicate good whale-ground."—*Am. Naturalist*, vii, 90, 1873.

Cuttle-fish are used so extensively for bait at Newfoundland, that half of all the cod taken is fished with them. The cuttle occurs "in vast abundance, but at different times on different coasts; for example, at St. Pierre in July, on the southern coasts of Newfoundland only in August, and in Bouna Bay first in September. Its vast shoals present a curious appearance, by their strongly twisted, compact form. When they approach, hundreds of vessels are ready for their capture. At this season of the year, the sea on the coast of St. Pierre is covered with from 400 to 500 sail of English and French ships, engaged in the cuttle-fish fishery. During violent gales of wind, hundreds of tons of them are often thrown up together in beds on the flat beaches, the decay of which spreads an intolerable effluvium around. It is made no use of, except for bait; and as it maintains itself in deeper water than the capelan, instead of nets being used to take it, it is jigged—a jigger being a number of hooks radiating from a fixed centre, made for the purpose. The cod is in best condition after having fed on it. Another method of taking them is sometimes resorted to. Fires are made all along the shore during the night, when the Loligo, attracted by the light, approaches too near for his safety, and is left on the strand by the recess of the tide, when the fishermen go to gather them."—*Edinb. New Phil. Journ.*, viii, 395.

In the Polynesian Islands, the natives have a curious contrivance for catching cuttle-fish. It consists of a straight piece of hard wood a foot long, round and polished, and not half an inch in diameter. Near one end of it, a number of beautiful pieces of the cowrie, or tiger shell, are fastened one over another, like the scales of a fish, until it is nearly the size of a turkey's egg, and resembles the cowrie. It is suspended in a horizontal position by a strong line, and lowered by the fisherman from a small canoe till it nearly reaches the bottom. The fisherman jerks the line to cause the shell to move, as if it were alive, and the jerking motion is called "tootoofe," the name of the contrivance. The cuttle-fish, attracted by the cowries, darts out one of its arms, and then another, and so on, until it is quite fastened among the

openings between the pieces of the cowrie, when it is drawn up into the canoe and secured.—*Lowell's Edible Mollusks*, 167.

Most of the species of octopods and the Nautilus are littoral in habit, and have thence been conjectured to enjoy but a limited distribution; and this is held to justify the multiplication of specific names. This reasoning is, however, fallacious, as it is well known that many littoral mollusks, not nearly so well provided as these with the means of swimming, have become world-wide in distribution. So many particular species of Octopus are known to inhabit the shores of distant countries, that a large proportion of the species which have been distinguished by slight and mutable characters, and by their geographical distribution, will probably need to be united when sufficiently studied. This probable extensive distribution of living littoral species corresponds with observations made upon fossil species of Ammonites, Nautilus and other chambered genera, which are proved to have been littoral in habit by their occurrence only in deposits representing ancient sea-shores. Not to multiply examples amongst these fossils, it may be mentioned that *Nautilus simplex* occurs in Europe, East Indies and Texas; that *Ammonites Rotomagensis* is found in Europe, East Indies, N. and S. Africa and S. America; and that *Baculites anceps* had even a wider distribution. Nevertheless, temperature has been observed to have some effect upon the distribution of the living Octopoda of Europe, similar but distinguishable forms or species inhabiting its northern seas, from those of the Mediterranean. As in Molluscan life generally, the development of specific forms has been greatest in tropical waters.

It is altogether probable that the pelagic cephalopods, highly organized, with powerful locomotive apparatus, and frequently attaining great size and strength, may enjoy a distribution fully equal to that of the littoral species: such is known to be the case in some species which, normally circumboreal in distribution, are found nevertheless extending into temperate latitudes in both oceans.

Order 1. DIBRANCHIATA.—Breathing by a single pair of internal symmetrical branchiæ or gills. Eyes sessile. Mandibles horny. Arms, eight or ten, furnished with rows of acetabulæ or suckers. Body sometimes laterally or posteriorly finned. Shell internal, or none.

Order 2. TETRABRANCHIATA.—Breathing by two pairs of symmetrical branchiæ. Eyes pedunculated. Mandibles shelly. Arms very numerous, without suckers. Shell external, chambered; capable of containing the animal.

Order I. DIBRANCHIATA.

Suborder 1. Octopoda.—Arms eight, sessile; no shell.

(The so-called shell of the argonaut, is the egg-nest of the female.)

Suborder 2. Decapoda.—Ten arms, of which eight are sessile, and two (longer) tentacular. Shell internal.

Suborder I. *OCTOPODA.*

(Littoral.)

Family Octopodidæ. Mantle supported by fleshy bands. No cephalic aquiferous pores. Arms subulate, elongated, more or less united by webs; their suckers sessile.

(Pelagic.)

Family Tremoctopidæ (Philonexidæ). Front of mantle supported by two cartilaginous buttons at the base of the siphuncle, fitting into grooves on the inner side of the mantle. Aquiferous pores on the back of the head. Suckers pedunculated.

Family Argonautidæ. Mantle supported by two buttons fitting into grooves at the base of the siphuncle. The two upper or dorsal arms (in the female only) expanding into velamenta or broad webs at their extremity, from which an egg-nest (shell) is secreted. Cups slightly pedicelled. A pair of aquiferous pores at the upper hinder angle of the eye.

Suborder II. *DECAPODA.*

A. Decapoda chondrophora. Internal shell horny.

a. Myopsidæ. Eyes covered by skin: mostly littoral species.

Family Loliginidæ. Body rather long; buccal skin sometimes armed with suckers; tentacular arms only partially retractile; fins lateral-terminal. Inner shell or gladius as long as the back.

Family Sepiolidæ. Body short; buccal skin without suckers; tentacular arms completely retractile; fins short, in the middle of the sides of the back. Gladius only about half as long as the body. First pair of dorsal arms hectocotylized in the male; spermatophores attached around the orifice of the oviduct.

b. Oigopsidæ. Eyes naked: pelagic species.

Family Cranchiidæ. Body rounded; mantle united to the head by a cervical band, and upon either side connate with the base of the siphon; head small, with large eyes; arms short; tentacles long; siphon long, not fastened to the head, and with or without inner valve. Shell or gladius as long as the body, small, lance-like.

Family Chiroteuthidæ. Body rather long; mantle supported on the body by cartilaginous ridges; sessile arms, long, partially

webbed; tentacles very long, not retractile; siphon short, without attachment to the head, or valve. Shell or gladius small, long, lance-like.

Family THYSANOTEUTHIDÆ. Body rather long or oval; mantle supported by cartilaginous ridges and grooves; arms free; siphon united to the head by two bands. Gladius dart-like.

Family ONYCHOTEUTHIDÆ. Body long, cylindrical; mantle supported by cartilaginous projections; eyes with a lachrymal sinus; arms or tentacles armed with hooks; siphon with or without bands and valve. Gladius generally lancet-form, with an end-conus.

Family OMMATOSTREPHIDÆ. Body long, cylindrical; arms short, armed with suckers only; the short tentacular arms non-retractile; siphon valved, united by bands to the head. Shell small, lancet-form, with an end-conus.

B. Decapoda calciphora. Internal shell calcareous.

a. Sepiophora. Shell blade-like.

Family SEPIIDÆ. Eyes covered by skin; littoral. Body oval, with long lateral fins, uniting behind; mantle supported by cartilaginous tubercles fitting into sockets on the neck and siphon; arms with suckers, tentacular arms entirely retractile; siphon valved. Shell (cuttle-bone, sepion or sepiostaire) broad, flat, thickened internally by numerous plates, terminating behind in a hollow, imperfectly chambered apex or mucro, without connecting siphon.

b. Phragmophora. Shell forming a series of chambers traversed by a siphon.

Family BELOSEPIIDÆ. (Fossil only.) Shell like Sepia, but the walls of the chambers of the mucro pierced by small holes, indicating the existence of a connecting siphon. Animal unknown.

Family BELEMNITIDÆ. (Fossil only.) Animal, arms with hooks. Shell a pen (pro-ostracum) attached to a chambered cone (phragmocone), the partitions of which are pierced by a submarginal, ventrally-placed siphuncle; at the hinder end the phragmocone is enveloped by a rostrum.

Family SPIRULIDÆ. Animal, body oblong, with minute terminal fins; mantle supported by a cervical and two ventral ridges and grooves; arms with six rows of minute cups; tentacular arms elongated; siphon valved. Shell spiral, whorls on the same plane, not in connection, chambered; chambers connected by a ventral siphon, invested by a series of cone-shaped tubes, one for each chamber. The shell is placed vertically in the end of the body, and is held in place by side flaps of the mantle.

The above succession of families indicates a progression from the so-called naked octopods (with the internal shell represented

by cartilaginous styles), through the cartilaginous-shelled Cirroteuthis, to the decapods with horny pens:—then those with calcareous plates and minute initial chambers, the latter of which gradually become larger, are siphunculated, curve, become spiral and thus form a passage into the fossil tetrabranchiates and the externally-shelled Nautilus. It is not impossible that in some of the ancient genera, the structure of the animals was such as to bridge over the gulf which now exists between the two orders: this has been recently maintained by M. Munier-Chalmas, and more cautiously by Dr. Paul Fischer.

SUBORDER I. *OCTOPODA.*

Animal bursiform, body rounded or ovoid; eyes fixed; shell usually absent, sometimes represented by internal cartilaginous stylets, or externally by a calcareous nest for the eggs, formed by the female only; siphon without valve; eight arms with fleshy suckers (without corneous rings) on their inner face. Males modifying one of their arms for copulation, and frequently detaching it during the act.

FAMILY OCTOPODIDÆ.

Synopsis of Genera.

a. Arms with two rows of suckers.

** Body not finned.*

OCTOPUS. Body rounded. Arms long. Suckers sessile. Third right arm of male hectocotylized.

CISTOPUS. Differs from Octopus in having a small aquiferous system, consisting of a bag with a small pore at its lower edge, upon the web between each arm.

SCÆURGUS. Body oval, wider than the head; arms short; cups with narrowed bases. Third left arm hectocotylized.

ALLOPOSUS. Arms united by a web nearly to the ends.

** * Body finned.*

PINNOCTOPUS.

b. Arms with a single row of suckers.

** Not finned.*

ELEDONE. Body rounded, without fins. Third right arm hectocotylized.

BOLITÆNA. More gelatinous than Eledone; suckers smaller, less developed.

** * Finned.*

CIRROTEUTHIS. Body with two transverse medial fins; mantle united to the head nearly all round, by a cervical band; arms united by a web nearly to their tips.

c. Arms with three rows of suckers.

TRITAXEOPUS.

OCTOPUS, Lamarck, 1799.

Etym.—*Octo*, eight; *pous* (*poda*), feet. *Poulpe.*
Syn.—Polypus, Leach, 1817.
Distr.—44 species. Coasts of temperate and tropical seas. *O. Cuvieri*, d'Orb. (xxiii, 5); *O. octopodia*, Linn. (xxiii, 1).

Animal with a rounded body, not finned at the sides or extremity; the eight long arms provided on their inner surface with two rows of sessile fleshy suckers; mantle-support fleshy. Shell represented by two short cartilaginous stylets enclosed in the tissues of the mantle. The third right arm of the male is altered for sexual purposes.

Verany says, that although the Octopus usually hides itself in the crevices of rocks, which the elasticity of its body enables it to do with great facility, it sometimes frequents sandy bottoms. On these occasions, as he has several times observed, it covers itself with *debris* by means of its suckers, and thus hid, patiently awaits its prey. The Poulpes are fished by means of an edible morsel, attached to a line, and slowly moved about their retreat. An individual having enveloped the bait in his arms, is gently drawn sufficiently near to the fisherman to enter a small hand-net. In summer, the young octopods are caught by means of a line armed with several hooks garnished with red cloth. By quickly drawing in the line, the animals may be captured. This is considered a fine pastime for the fine summer evenings at Nice. The Octopus retains his vitality for a long time out of the water, so that the fisherman is compelled to kill him at once with his knife, to prevent escape.

The meat of the Octopus has a well-marked taste, and is excellent when young. It is regularly sold by fishermen in the markets of Southern Europe. A section of an arm shows a white, firm flesh, resembling in appearance steaks of halibut.

The largest Octopus seen by Verany was over three yards in length, and weighed 25 kilogrammes; it was captured by a fisherman with his hands only, after a fatiguing struggle.

The action of the suckers of the Poulpe upon the skin, the serpentine motion and muscular force of its arms, and its hideous aspect, have caused to be exaggerated, says M. Verany, the misdeeds of this cephalopod, which is stupid and incapable of harm.

Mr. Jeffreys, in his admirable "British Conchology," states that the Octopus feeds principally on bivalves. The heaps of shells around their dens, which are uncovered during the recess of spring tides at Herm, are enormous; in one of these heaps, more than two thousand shells were counted, principally species of Tapes.

Lord's "Naturalist in British Columbia" contains the following account of the Octopus:

"The ordinary resting-place of this hideous sea-beast is under

a large stone, or in the wide cleft of a rock, where an Octopus can creep and squeeze itself with the flatness of a sand-dab, or the slipperiness of an eel. Its modes of locomotion are curious and varied; using the eight arms as paddles, and working them alternately, the central disk representing a boat, octopi row themselves along with an ease and celerity comparable to the many-oared caïque that glides over the tranquil waters of the Bosphorus; they can ramble at will over the sandy roadways, intersecting their submarine parks, and converting arms into legs, march on like a huge spider. Gymnasts of the highest order, they climb the slippery ledges, as flies walk up a window-pane; attaching the countless suckers that arm the terrible limbs to the face of the rocks, or to the wrack and sea-weed, they go about back downward, like marine sloths, or, clinging with one arm to the waving algæ, perform series of trapeze movements that Leôtard might view with envy.

"I do not think, in its native element, an Octopus often catches prey on the ground or on the rocks, but waits for them just as the spider does, only the Octopus converts itself into a web, and a fearful one too. Fastening one arm to a stout stalk of the great sea-wrack, stiffening out the other seven, one would hardly know it from the wrack amongst which it is concealed. Patiently he bides his time, until presently a shoal of fish come gaily on. Two or three of them rub against the arms: fatal touch! As though a powerful electric shock had passed through the fish, and suddenly knocked it senseless, so does the arm of the Octopus paralyze its victim; then winding a great sucker-clad cable round the palsied fish, he draws the dainty morsel to the centre of the disk, where the beaked mouth seizes, and soon sucks it in.

"I am perfectly sure, from frequent observations, the Octopus has the power of numbing its prey; and the sucking disks along each ray are more for the purposes of climbing and holding on whilst fishing, than for capturing and detaining slippery prisoners.

"The Indian looks upon the Octopus as an alderman does on turtle, and devours it with equal gusto and relish, only the savage roasts the glutinous carcase instead of boiling it. His mode of catching octopi is crafty in the extreme, for redskin well knows, from past experience, that were the Octopus once to get some of its huge arms over the side of the canoe, and at the same time a holdfast on the wrack, it could as easily haul it over as a child could upset a basket. Paddling the canoe close to the rocks, and quietly pushing aside the wrack, the savage peers through the crystal water, until his practised eye detects an Octopus, with its great rope-like arms stiffened out, waiting patiently for food. His spear is twelve feet long, armed at the end with four pieces of hard wood, made harder by being baked and charred in the

fire: these project about fourteen inches beyond the spear-haft, each piece having a barb on one side, and are arranged in a circle round the spear-end, and lashed firmly on with cedar-bark. Having spied out the Octopus, the hunter passes the spear carefully through the water until within an inch or so of the centre disk, and then sends it in as deep as he can plunge it. Writhing with pain and passion, the Octopus coils its terrible arms round the haft; redskin, making the side of his canoe a fulcrum for his spear, keeps the struggling monster well off, and raises it to the surface of the water. It is dangerous now; if it could get a hold-fast on either savage or canoe, nothing short of chopping off the arms piecemeal would be of any avail.

"But the wily redskin knows all this, and has taken care to have another spear, unbarbed, long, straight, smooth, and very sharp, and with this he stabs the Octopus where the arms join the central disk. I suppose the spear must break down the nervous ganglions supplying motive power, as the stabbed arms lose at once strength and tenacity; the suckers, that a moment before held on with a force ten men could not have overcome, relax, and the entire ray hangs like a dead snake, a limp, lifeless mass. And thus the Indian stabs and stabs, until the Octopus, deprived of all power to do harm, is dragged into the canoe, a great, inert, quivering lump of brown-looking jelly."

Mrs. Lucie L. Hartt thus relates her experience with an Octopus:

"It was during my first visit to Brazil, that one day, while busily engaged in examining a reef at a little town on the coast called Guarapary, my eye fell on an object in a shallow tide-pool, packed away in the crevice of the reef, which excited my curiosity. I could see nothing but a pair of very bright eyes; but, concluding that the eyes had an owner, I determined very rashly to secure him. I had been handling corals, and seemed to have forgotten that all the inhabitants of the sea are not harmless. I put my hand down very quietly so as not to ruffle the water, when, suddenly, to my surprise, it was seized with a pressure far too ardent to be agreeable, and I was held fast. I tugged hard to get away, but this uncivil individual, whoever he was, evidently had as strong a hold on the rocks as he had on my hand, and was not easily to be persuaded to let go of either. At last, however, he became convinced that he must choose between us, and so let go his hold upon the rocks, and I found clinging to my right hand, by his long arms, a large octopod cuttle-fish, and I began to suspect that I had caught a Tartar. His long arms were wound around my hand, and these arms, by the way, were covered with rows of suckers, somewhat like those with which boys lift stones, and escape from them was almost impossible. I

knew that this fellow's sucking propensities were not his worst ones, for these cuttle-fishes are furnished with sharp jaws, and they know how to use them too, so I attempted to get rid of him. But the rascal, disengaging one slimy arm, wound it about my left hand also, and I was a helpless prisoner. In vain I struggled to free myself—he only clasped me the tighter. In vain I shouted to my companion—he had wandered out of hearing. I was momentarily expecting to be bitten, when the "bicho" suddenly changed his mind. I was never able to discover whether he was smitten with remorse and retired with amiable intentions, or whether he only yielded to the force of circumstances. At any rate he suddenly relinquished his hold upon my hands and dropped to the sand. Then raising himself on his long, limsy arms, he stalked away towards the water, making such a comical figure, that, in spite of my fright, I indulged in a hearty laugh. He looked like a huge and a very tipsy spider, staggering away on his exceedingly long legs.

"Cuttle-fishes are sometimes used for food by the Brazilians, and different species may be seen in the markets, where one frequently finds them still alive. Sometimes, as he stoops to examine one, its body is suddenly suffused with a deep pinkish glow. Before he has time to recover from his surprise, this color fades, and a beautiful blue takes its place as rapidly as a blush sometimes suffuses a delicate cheek. The blue, perhaps, is succeeded by a green, and then the whole body becomes pink again. One can hardly conceive anything more beautiful than this rapid play of colors, which is produced by the successive distention of sets of little sacks containing fluids of different colors, which are situated under the skin."—*American Naturalist*, iii, 256, 1870.

"The British Vice-Consul, Green, in a recent report, furnishes some novel and interesting particulars as to the fishing and trade in cephalopods in the Tunis waters. Octopodia and polypi are the trade names under which these cephalopods are known in the Levant and Greek markets, where they are solely imported for consumption during Lent, the orthodox Church not including them in the prohibition against the use of flesh in seasons of religious abstinence.

"They prefer rocky shallows, and visit these waters, coming from the open sea in the months of January, February and March. A considerable number of octopodia, however, remain permanently near the shores; but it has been observed that when their fry, locally called 'muschi,' are numerous from the month of June to August, the fishing of the coming season is sure to be abundant, whilst the reverse is the case if they appear in numbers in November and December. In a good season, the

several villages on the Island of Karkenah supply about 3000 cwts., and the Jubah waters a third part of this quantity. On the shores from the village of Luesa to that of Chenies, in the Gulf of Khabs, the natives collect from 4 to 5 cwts. of cuttle-fish a day, during the season; but this supply generally serves for the consumption of the regency.

"The Tunisian Government claims a third of all the polypi fished upon its coast. The selling price varies from 25 to 50 shillings per cwt. Polypi are prepared for exportation by simply salting and drying them. Malta receives the largest share of the Tunisian polypi, but they are only sent to that island for ultimate transportation to Greece and other parts of the Levant.

"Portugal is one of the few countries that competes with Tunis in supplying the Greek markets with polypi. In Greece they are either sold after being pickled, at from £12. 16s., to £15. 9s., the cantar of 176 lbs., or in their original dried state, at £12 to £14, but these prices fluctuate according to the results of the season's fishing.

"Polypi are taken in deep water by means of earthen jars strung together and lowered to the bottom of the sea, where they are allowed to remain for a certain number of hours, and in which the animals introduce themselves. Frequently from eight to ten polypi are taken from every jar at each visit of the fishermen. In less deep water earthenware drain-pipes are placed side by side, for distances frequently exceeding half a mile in length, and in these also they enter, and are taken by the fishermen. As they are attracted by white and all smooth and bright substances, the natives deck places in the creeks and hollows in the rocks, with white rocks and shells, over which the polypi spread themselves, and are caught from four to eight at a time. But the most successful manner of securing them is pursued by the inhabitants of Karkenah, who form long lanes and labyrinths in the shallows, by planting the butt-ends of palm branches at short distances from each other, and these constructions extend over spaces of two or more miles. On the ebb of the tide (the fall is here about 10 feet) the octopodia are found in the pools inside the enclosures, and are easily collected by the fishermen, who string them in bunches of fifty each, and from eight to ten of these bunches, called 'risina,' are secured daily during the season, by every boat's crew of four men."—SIMMONDS, *Commercial Products of the Sea.*

AMPHIOCTOPUS, Fischer, 1882. Proposed for *O. membranaceus*, Quoy, the body of which is provided with a thin membrane on either side, not reaching its extremity.

PTEROCTOPUS, Fischer, 1882. Arms united to their extremity by a membrane. *O. tetracirrhus*, Delle Chiaje. Mediterranean

CISTOPUS, Gray, 1849.

Distr.—Only two species known; Celebes, India, Patagonia. *C. Indicus*, Rüppell (xxiii, 6).

Body without fins; arms with two rows of sessile suckers; upon the web connecting the arms is a bag opening by a small pore between each pair of arms.

SCÆURGUS, Troschel, 1857.

Distr.—Two species; Mediterranean Sea.

Body oval, wider than the head; arms short; cups or suckers with narrow bases. Third left arm hectocotylized.

As the principal character on which this genus is founded, is the hectocotylized arm of the male, it is sometimes impossible to ascertain whether specimens belong to this genus or to Octopus. It is very probable that some of the species described under Octopus should be placed here.

ALLOPOSUS, Verrill, 1880.

Distr.—*A. mollis*, Verrill (xxiv, 13). 100 m. S. of Newport, R. I.

Allied to Philonexis and Tremoctopus. Body thick and soft, smooth; arms united by a web nearly to the ends; suckers in two rows, sessile; mantle firmly united to head by a ventral and two lateral commissures and by a broad dorsal band; siphon short, well forward. Right arm of third pair hectocotylized in the male, and developed in a sac in front of the right eye.

PINNOCTOPUS, Orb., 1845.

Finned Octopus.

Distr.—*P. cordiformis*, d'Orb. (xxiv, 12). New Zealand.

Body like *Octopus* but finned; arms with two rows of suckers.

ELEDONE, Leach, 1817.

Syn.—Polypus, Owen. Moschites, Schneider, 1784. Ozæna, Raf., 1814.

Distr.—Three species: Norway, Britain, Mediterranean Sea. *E. Aldrovandi*, Chiaje (xxiv, 11).

Body rounded, without fins; the arms with a single row of suckers. Third right arm hectocotylized.

E. moschatus inhabits from 10 to 100 metres in depth, rocky as well as sandy shores of the Mediterranean Sea; it appears in the markets of Genoa in quantities from September to May. It is able to throw itself out of the water to a distance of 8 or 10 feet, and can also eject water from its funnel for over a foot. Verany has seen it repeat this jet eight times, taking six to eight respirations between each jet.

Notwithstanding its musky odor, this species is largely used for food; some skin it, and others use seasoning to diminish this

odor. Its flesh is more tender than that of the Octopus, but it has less taste and is not so well liked. It is used boiled, as a salad, fried or as a ragoût.

The women of the tribe of M'talassa (Algiers), anoint their hair with the black liquid which they collect from this mollusk, but whether they use it as a dye or for the sake of its musk-like perfume, is not known. The perfume appears to be capable of industrial use.—AUCAPITAINE, *Rev. et Mag. Zool.*, 366, 1862.

Johnston says of *E. octopodia*, a species common in Northern Europe: "When at rest, this octopod lies prone on the belly, the arms spread out in front, with their extremities exposed in spirals on the sides. It has in this position a considerable likeness to a toad; and, often raising the back and head, its aspect is really repulsive and threatening. It moves quickly, and always retrograde, playing its arms in a regulated, graceful manner, which no one can contemplate without wonder in a body so grotesque and apparently so inapt for locomotion."—*Proc. Berw. N. H. Club*, i, 198.

BOLITÆNA, Steenstrup, 1850.

More gelatinous than Eledone; suckers smaller, less developed.

In the description of this genus no type is cited. In Woodward and Keferstein a single living species is mentioned, but without name.

CIRROTEUTHIS, Eschricht, 1836.

Etym.—*Cirrus*, a filament, *teuthis*, a cuttle-fish.

Syn.—Bostrychoteuthis, Agass., 1847. Sciadephorus, Rein. and Proch, 1846.

Distr.—*C. Mulleri*, Esch. (xxiii, 7). Greenland.

Body with two transverse medial fins; mantle united to the head nearly all round, by a cervical band; arms united by a web nearly to their tips.

STAUROTEUTHIS, Verrill, 1879. Allied to Cirroteuthis, but with the mantle united to the head all around, and to the dorsal side of the slender siphon, which it surrounds like a close collar, leaving only a very narrow opening around the base of the siphon laterally and ventrally. Fins triangular, in advance of the middle of the body. Dorsal cartilage forming a median angle directed backward. Body flattened, soft, bordered by a membrane. Eyes covered by the integument. Web not reaching the tips of the arms. Suckers in one row. Right arm of second pair is altered, in the male, at the tip. *S. Syrtensis*, Verrill. Near Sable Island.

TRITAXEOPUS, Owen, 1881.

Distr.—*T. cornutus*, Owen (xxiii, 10). Australia.

Body not finned; suckers on the arms three-ranked.

FAMILY TREMOCTOPIDÆ.

TREMOCTOPUS, Chiaje, 1830.

Etym.—*Tremata*, pores, and *Octopus*.

Syn.—Philonexis, d'Orb., 1835.

Distr.—6 species; Mediterranean, Atlantic, N. Pacific, Mauritius. *T. violaceus*, Chiaje (xxiii, 8).

Body rounded, head large, band of the neck very small. Funnel short. Two aquiferous pores in the neck. Third right arm hectocotylized, fringed on the sides, and developed in a sack-like aperture on the side of the head. Two first pairs of arms united by a web in the female (not in the male), other arms free.

PARASIRA, Steenstrup, 1861.

Distr.—2 sp.; Mediterranean. *P. catenulata*, Fer. (xxiii, 9).

Body rounded; head small and short; neck band rather broad. Funnel long. No water-pores in the neck, two at the base of the siphon. Third right arm hectocotylized, not fringed, developed from a pedicelled sack. Male very different from the larger female.

The flesh of this mollusk is tough and unwholesome, and for these reasons is not sold in the Italian markets. The Genoese fishermen make of the skin of the body a sort of cap, whereof the reticulations serve as ornaments.

HALIPHRON, Steenstrup, 1858.

Arm only known. With bell-shaped cups, having lily-like borders.

Described from a single arm found in the stomach of a shark. No species characterized.

FAMILY ARGONAUTIDÆ.

ARGONAUTA, Linn., 1756.

Argonaut, or *Paper Nautilus*. *Argonautai*, sailors of the ship Argo. *Syn.*—Ocythoë, Leach (not Rafin.), 1817.

Distr.—9 sp. All warm seas. *A. Argo* (xxiv, 18) is found in the tropical Pacific, Indian and Atlantic Oceans; Gulf of California, Mediterranean, Cape of Good Hope. *Fossil*, 2 species, Tertiary of Europe.

Characters, those of the family (p. 12). The third right arm of the male is hectocotylized.

The *shell* of the Argonaut is thin and translucent; it is not moulded on the body of the animal, nor is it attached by shell-muscles; and the unoccupied hollow of the spire serves as a receptacle for the minute clustered eggs (xviii, 15). The shell

is peculiar to the female: its special function is for the protection and incubation of the eggs. It is not homologous with the chambered or internal rudimental shells of other cephalopods, but may be compared with the cocoon of the leech, or the float of Ianthina. The Argonaut sits in its boat with its siphon turned towards the keel, and its sail-shaped (dorsal) arms closely applied to the sides of the shell It swims by ejecting water from its funnel, and crawls in a reversed position, carrying its shell over its back like a snail.

The male Argonauts (xvi, 84, 85), are one inch in length, and possess no shell; their dorsal arms are pointed, not expanded. The testis is large, and like that of the Octopus in structure and situation; it contains spermatozoa of different degrees of development, and the excretory duct probably debouches into the hectocotylus.

A living Argonaut was captured at Long Branch, New Jersey, by a fisherman, in August, 1876. It was kept alive for eight or nine days and made feeble attempts to swim in its narrow confinement (*Am. Nat.*, xi, 243). Numbers of fresh shells have been recently dredged, about 90 miles south of Narraganset Bay, R. I., by the U. S. Fish Commission.

The occurrence of the Argonaut on the Florida coast, in one instance with the animal entire, is mentioned in *Am. Nat.*, xii, 397.

Dr. H. Müller observes that the female Argonaut appears periodically in great numbers at Messina during the spawning season, but at other times her usual habitat is at the bottom in deep waters. The male is always very small, and is rarely met with: its hectocotylized arm is detached during coition and is found in the mantle of the female, where it enjoys a prolonged separate life, although unprovided with digestive organs. The young female an inch in length, has no shell; it is developed later.

In South Australia, at certain seasons of the year, during the prevalence of strong northerly winds, the shells of the female Argonaut are washed ashore in considerable numbers. Many of these shells contain the animal in a living state; but they soon fall a prey to the sea-gulls, by whom they are greedily devoured.

SUBORDER II. *DECAPODA.*

Body oblong, laterally finned; arms consisting of eight normal (sessile) ones, and two longer or tentacular arms, which are contractile or retractile; suckers provided with corneous rings, sometimes armed with teeth, or with hooks; shell dorsal, internal. One or two of the sessile arms are modified for copulation.

FAMILY LOLIGINIDÆ.

LOLIGO (Pliny), Lamarck, 1801.

Calamary. *Syn.*—Pteroteuthis, Blainv.

Distr.—31 sp.; all seas, Norway, United States, New Zealand.

L. Pealii, Lesueur (xxv, 20–22).

Body long, with posterior rhombic fins united behind; mantle supported by a cervical ridge and by cup-like cartilages on the base of the funnel or siphon; siphon valved, attached by bands to the head; arms with two rows of suckers provided with horny, dentated rings; tentacular arms with four rows of suckers on their clubs. Fourth left arm hectocotylized at its extremity. Gladius feather-like, its shaft keeled on the ventral side.

The calamaries are good swimmers; they are found in all parts of the world. Owen mentions that the pens are sometimes duplicated in old specimens, several being found packed closely, one behind another. The suckers on the margins of the projections of the buccal membrane are doubtless additional prehensile organs very useful in assisting in holding the food to the mouth. There appear to be two types of form in the gladius or internal shell: that in which the wings are expanded, with convex margins, and that in which they are narrow, with nearly straight margins.

The so-called artificial eyes of the ancient Indian mummies of Arica, Peru, are, according to Tschudi, the dried eyes of *Loligo gigas* inserted in lieu of the natural organs. According to Verrill, numbers of the young of the American *Loligo Pealii* are often found in the stomach of the red jelly-fish. Of *L. pallida*, a closely allied or identical species, Mr. Verrill says: "These squids are eagerly devoured, even when full-grown, by many of the larger fishes, such as blue-fish, black-bass, striped-bass, etc. When young they are preyed upon by a still larger variety of fishes. It is often taken in the seines in large numbers with menhaden, upon which it probably feeds."

On the 30th of November, 1860, the French steamer Alecton, commanded by Lieut. Bouyer, encountered, between Madeira and Teneriffe, an enormous Poulpe, which was swimming on the surface of the water. The animal measured 15 to 18 feet in length, without counting the formidable arms, covered with cups, which crowned its head. Its color was brick-red; its eyes had a prodigious development and frightful fixity. Its mouth, like the beak of a parrot, could be opened to the extent of 18 inches. Its body, fusiform but much swelled towards the centre, presented an enormous mass, the weight of which has been estimated at more than 4400 pounds. Its fins, situated at the posterior extremity, were rounded in two fleshy lobes and of

very large size. The commander of the vessel, on perceiving it, halted upon his course and made preparations for capturing the monster. Guns were charged and harpoons hastily prepared; but at the first discharge of the former, the animal dived under the ship and immediately appeared on the other side. Attacked again with harpoons, it disappeared two or three times, and, each time that it reascended to the surface, its long arms writhed. The ship followed or arrested its course according to the movements of the animal. This chase lasted more than three hours. The commander of the Alecton was determined to capture this new kind of enemy; nevertheless he did not dare to lower a boat, for a single arm of this cephalopod would suffice to overturn it. The harpoons which were launched at it penetrated the flabby flesh and came out without success; several balls traversed it also unsuccessfully. Nevertheless it received one of them which appeared to wound it badly, causing it to vomit a great quantity of frothy matter and blood mixed with viscid matter which spread a strong odor of musk. It was at this instant that they succeeded in lassooing the animal, but the rope slid along the elastic body until arrested by the fins. Attempting to haul their prize aboard, they had already raised the greater part of the animal from the water when its enormous weight caused the rope to penetrate the flesh and separate the posterior portion of the body—which was drawn on board, whilst the rest disappeared in the sea.

The above is condensed from a letter addressed to M. Moquin-Tandon, by M. Sabin Bertholet, consul of France, at the Canaries, who saw the fragment alluded to, and received the relation of the commandant of the vessel. One of the officers made a sketch of this animal, which, in conjunction with the description, is considered by Messrs. Crosse and Fisher sufficiently exact to warrant them in determining it to belong to a new species of Loligo, which they name *L. Bouyeri*. The figure and description show but eight arms, but the elongated form of the body, the proportional shortness of the arms and the presence of the posterior fins, show it to have been one of the decapods. Probably the tentacular arms were either deficient or were not seen.

LOLIGUNCULA, Steenstrup, 1881. Swimming lobes thick, wide and very short, forming together a transverse oval; female receiving the spermatophores upon the interior wall of the mantle, alongside the left branchia. *L. brevis*, Blainv. (xxv, 23). Characters perhaps insufficient.

TEUTHIS, Gray, 1849. Buccal membrane without suckers. A single European species, *L. media*. It was known to Aristotle and the ancients; and is highly esteemed for food in Italy.

LOLIOLUS, Steenstrup, 1856.

Distr.—3 species; Gulf of California, Indian Ocean. *L. affinis*, Steenst. (xxv, 30).

Body rather long, with posterior round fins united behind; siphon not attached to the head. Fourth left arm hectocotylized in its entire length. Gladius feather-like, broad. Otherwise as in Loligo.

Loligo hemiptera, *L. brevipinna*, and other Loligines with blunt extremity and round fins, may perhaps belong to this small group, which is not widely separated by its characters from Loligo.

SEPIOTEUTHIS, Blainv., 1824.

Syn.—Chondrosepia, Leuck, 1826.

Distr.—14 species; West Indies, Cape, Red Sea, Java, Australia, Mediterranean, Madagascar, Sandwich Islands. *S. Stenodactyla*, Grant (xxv, 24). *S. lunulata*, Fer. Orb. (xxv, 25).

Body rather long or oval, with small lateral fins extending its entire length; siphon attached to the head by muscular bands; buccal skin with seven projections covered with suckers; a strong wrinkle behind the eyes. Fourth left arm hectocotylized at its extremity. Otherwise like Loligo.

TEUTHOPSIS, Deslongchamps, 1835.

Etym.—*Teuthis*, a calamary, and *opsis*, like.

Distr.—A few species known, fossil in the lias of France and Wurtemberg. *T. Bunnellii*, Desl. (xxviii, 55, 56).

Pen or gladius dilated and spatulate behind, its wings curved towards the ventral side somewhat spoon-like.

LEPTOTEUTHIS, Meyer, 1834.

Etym.—*Leptos*, thin, and *teuthis*, a calamary.

Distr.—*L. gigas*, Meyer (xxviii, 57). Oxford clay, Solenhofen.

Shaft of the pen enlarging from a point to a broad blade in front, with long, lateral wings starting from the posterior pointed end.

BELEMNOSEPIA, Agassiz, 1836.

Syn.—Belopeltis, Voltz; Geoteuthis, Münst., 1843; Loligosepia, Queenst., 1839; Palæosepia, Theodori, 1844.

Distr.—9 sp. Fossil, in the Upper Lias of Wurtemburg, Calvados and Lyme Regis. *B. lata*, Münst. (xxviii, 63).

Gladius like Leptoteuthis and perhaps not separable from it. The shaft is more triangular, and the lateral wings broader, with more rounded outlines.

Besides the pens of this calamary, the ink-bag, mantle and bases of the arms, as well as the horny shells, are preserved. Some of the ink-bags are nearly a foot in length, and are invested

with a brilliant nacreous layer. So indestructible is this fossil ink that it is yet capable of use as Sepia. It is difficult to understand how it was preserved, as the recent calamaries spill their ink on the slightest alarm.

BELOTEUTHIS, Münster, 1843.

Etym.—*Belos*, a dart, and *teuthis*. *Syn.*—Sepiolites, Münster.

Distr.—*B. subcostata*, Münst. (xxviii, 58). Upper Lias of Wurtemburg.

Gladius. Shaft lozenge-shaped, pointed at each end, with posterior lateral wings.

PHYLLOTEUTHIS, Meek and Hayden, 1860.

Distr.—*P. subovata*, M. and H. (xxviii, 59). Upper Cretaceous, Dakota.

Gladius thin, subovate, slightly concave below, and convex above. From behind the middle it narrows towards the front, the outline of the lateral margins being convex, while the posterior end is more or less obtusely angular.

This genus is founded on the impression of the expanded part of a gladius in a mass of rock; it was evidently thin, and as no part of its substance remains, is supposed to have been corneous. It looks very like Beloteuthis.

PTILOTEUTHIS, Gabb, 1869.

Distr.—*P. foliatus*, Gabb (xxviii, 60). Cretaceous, California.

Gladius elongate, subovate, very thin, anterior end broadly angulated, no midrib; surface marked by numerous, irregular, small wrinkles, which radiate backwards and outwards, partly from the anterior end, and partly from an imaginary median line.

[SCAPTORRHYNCHUS, Bellardi.]

Founded on decapod beaks discovered in the tertiary of Piedmont. *S. miocenicus*, Bellardi (xxviii 75–77).

FAMILY SEPIOLIDÆ.

SEPIOLA, Leach, 1817.

Syn.—Sepioloidea, d'Orb, 1839. Fidenas, Gray, 1849.

Distr.—7 sp. European Seas, Japan, Mauritius, Viti Is., Australia, Singapore, Coast of Maine, U. S.

Body short, purse-like, mantle united to the head cervically, and ventrally supported by a ridge fitting a groove on the funnel; arms with two or eight rows of pedunculated suckers, the rings of which are not toothed, and eight rows of very small ones on the tentacular clubs. Fins oval, dorsal. Gladius lancet-form, only half as long as the body, margins thickened. First left arm hectocotylized.

Mr. Alder says of *S. Sepiola*, the common European species: "This is an odd fish, crouching generally at the bottom like a toad, with its great goggle-eyes half closed, and sometimes crawling along by means of its suckers, puffing the water through the funnel all the time. When it does take to swimming, it darts very quickly through the water, and is difficult to catch. When taken out of the water and placed on the hand, it had recourse to an odd mode of progression, turning two or three somersets in tumbler-fashion, first laying hold with its arms, turning over and laying hold again until it managed to get back into the water." It is said by Mr. Gosse, to burrow in the sand by blowing through its funnel, and using its arms, with their suckers, to remove small stones and gravel. They spawn towards the end of May or beginning of June. The eggs are arranged in the centre of a bluish gelatinous mass, as if around an axis, and fifteen to thirty of these masses, each containing from forty to one hundred and thirty eggs, are united, each by a basal stalk, to form a group attached upon some submarine body. The fry is hatched in twenty-two to twenty-five days. They visit the Algerine coast in numerous troops during the month of May, for the purpose of spawning. In the Mediterranean it is found at depths of 60 to 200 mètres, where it lives in company with the Eledones. Largely consumed as food in Italy; it is much esteemed for the delicacy of its flesh.

S. Penares, Gray, the type of Gray's genus *Fidenas*, does not appear to possess any distinctive characters, except that the suckers are long-peduncled, and the peduncles are constricted on the upper part. The only specimen is in spirits, and is in a mutilated state.

ROSSIA, Owen, 1834.

Dedicated to Capt. John Ross, the Arctic voyager.

Syn.—Heteroteuthis, Gray, 1849.

Distr.—10 sp. Arctic Seas, Great Britain, Massachusetts Bay, Mediterranean. *R. Owenii*, Ball (xxv, 27).

Generally like Sepiola, but the mantle is supported cervically by a ridge; arms with two or four rows of sessile suckers. First left arm and middle of first right arm hectocotylized. Shell lancet-form, small.

Owen thinks that the eyelids discovered in *Rossia palpebrosa*, and from which it derives its name, are a peculiar organization designed as a defense for the eyes against the spicular ice crystals, which, in the summer season, crowd the northern waters.

The eggs of Rossia are laid singly, one alongside of another, and fixed solely by their viscous surface.

SEPIADARIUM, Steenstrup, 1881.

Distr.—*S. Kochii*, Steenstrup (xxv, 29). Japan.

Dorsal lamina or pen absent. Cartilaginous support wanting, the mantle and siphon being united by a muscular ligament; mantle border joined dorsally to the neck.

IDIOSEPIUS, Steenstrup, 1881.

Distr.—*I. pygmæus*, Steenstrup (xxv, 26). Indian Ocean.

No dorsal lamina or pen, but instead of it there is, under the mantle, a singular ring-like tendinous support; cartilage-button oval, with corresponding fosset.

STOLOTEUTHIS, Verrill, 1882.

Distr.—*S. leucoptera*, Verrill. Off Martha's Vineyard, Mass.

Body short and thick, well rounded; head large, united to mantle by a broad dorsal commissure; eyes large, pupils round; eyelids free all around; no pen; mantle thick, extending farther forward beneath than laterally; fins large, lateral; siphon with an internal valve in both sexes; connective cartilages long, with a central groove, fitting a linear ridge on each side of the mantle; arms webbed for more than half their length, except between the ventral arms; second pair in the male, and some females, with two or three much enlarged suckers near the middle.

INIOTEUTHIS, Verrill, 1882.

Distr.—2 sp. Japan.

Body, lateral fins, and dorsal commissure of mantle as in Sepiola; lateral connective cartilages of the siphon oblong-elliptical, with the groove open behind, fitting a linear ridge on each side of the mantle; eyelids free below, adherent above; pen absent; arms webbed only slightly at base; suckers both on sessile arms and tentacles, as in Rossia; left dorsal arm hectocotylized.

FAMILY CRANCHIIDÆ.

CRANCHIA, Leach, 1817.

In honor of *J. Cranch*, naturalist to the Congo expedition.

Distr.—3 sp. Congo, Africa; West Indies. *C. scabra*, Leach (xxv, 28).

Characters generally those of the family. Body short, rounded; fins very small, rounded, terminal; buccal membrane produced into eight lobes; arms short, with two rows of suckers; tentacular clubs finned behind, with suckers in eight rows. Siphon valved.

In *C. megalops*, the body is joined to the head by a pseudo-articulation; for which Prosch proposes the subgeneric name *Owenia*, 1847.

LOLIGOPSIS, Lamarck, 1812.

Etym.—*Loligo*, and *opsis*, like.

Syn.—Leachia, Lesueur, 1821; Taonius, Steenstrup, 1861; Desmoteuthis, Verrill, 1882.

Distr.—8 sp., pelagic. Northern Atlantic, Mediterranean, Indian and Pacific Oceans, Japan. *L. guttata*, Grant (xxvi, 35).

Body long, attenuated behind, with large fins; siphon not valved; tentacles long and slender.

PEROTIS, Esch., 1827. Sides with rows of acute tubercles; shell with solid tip. 2 sp.; Indian Ocean, tropical Atlantic.

FAMILY CHIROTEUTHIDÆ.

CHIROTEUTHIS, Orb., 1839.

Etym.—*Cheir*, the hand, and *teuthis*, a calamary.

Distr.—2 sp. Atlantic and Mediterranean; on gulf-weed. *C. Veranyi*, Fer. (xxvi, 31, 32).

Body long, attenuated; arms long, connected by a short basal web, with two rows of small, long-pedunculated suckers; tentacles very long and narrow, covered their whole length with scattered suckers, the clubs with four rows of long-pedunculated suckers. Pen slender in the middle, slightly winged at each end.

The great cephalic development of the animals of this very restricted genus, the immense length of the tentacles and the peculiar armament of their clubs, and the gladius expanded at each end, form excellent distinctive characters from the Loligopsidæ.

CALLITEUTHIS, Verrill, 1880. Body short, tapering to a free tip; fins small, united behind; siphon united to head by two dorsal bands, and having an internal valve; mantle connected to sides of siphon by lateral elongated cartilages and grooves; arms long, free, suckers in two rows, largest in middle of lateral and dorsal arms; eyes large, with oval openings; buccal membrane simple, sack-like; pen broad, lanceolate. *C. reversa*, Verrill (xxiv, 14). New England.

BRACHIOTEUTHIS, Verrill, 1882.

Distr.—*C. Beanii*, Verrill. Off Martha's Vineyard, Mass.

Allied to Chiroteuthis; differs in having the lateral connective cartilages of the siphon simple, long-ovate, and the corresponding cartilages of the mantle in the form of simple, linear ridges; a rhombic caudal fin; pen with a simple, linear, anterior portion, suddenly expanding into a much broader, lanceolate, posterior portion, which is naturally infolded; arms slender, the ventral ones not distinctly obliquely compressed; tentacular club with a spoon-like cavity at tip.

HISTIOTEUTHIS, d'Orbigny, 1839.

Etym.—*Histion*, a veil, and *teuthis*, a calamary.

Distr.—3 sp. Mediterranean Sea; off Nova Scotia. *H. Bonelliana*, Fer. (xxvi, 33, 34).

Body short, cylindrical; head long; arms long, the three superior pairs connected by a largely developed web, the ventral pair free; tentacles long, with six rows of dentated cups on their clubs; buccal membrane six-lobed. Pen short and broad.

FAMILY THYSANOTEUTHIDÆ.

THYSANOTEUTHIS, Troschel, 1857.

Etym.—*Thysanos*, a fringe, and *teuthis*, a calamary.

Distr.—2 sp. Mediterranean Sea. *T. rhombus*, Trosch. (xxvi, 36, 37).

Body with large triangular fins the whole length of each side; arms with lateral expansion of the skin, and two rows of pedunculated suckers, from which spring threads which are connate with the surface of the lateral expansions. Shell file-shaped.

FAMILY ONYCHOTEUTHIDÆ.

The principal character of this family is the development of hooks upon the arms, as a means of prehension; they replace the sucking disks to a greater or less extent, according to the several genera. A few fossil forms occur.

GONATUS, Gray, 1849.

Distr.—*G. amœna*, Möll. (xxvi, 38), is found on the coast of Greenland.

Body like Loligo; arms thick, with four rows of small suckers; tentacular clubs with many rows of small suckers, and a single large basal cup armed with a hook; siphon not connected to the head, without valve. Gladius lancet-form.

ONYCHOTEUTHIS, Lichtenstein, 1818.

Etym.—*Onyx*, a claw, and *teuthis*, a calamary.

Syn.—Ancistroteuthis, Gray, 1849.

Distr.—10 sp. Atlantic and Pacific O., arctic and tropical; Mediterranean. *O. Krohni*, Fer. et Orb. (xxvi, 39, 40).

Arms with two rows of suckers, the rings of which are not toothed; tentacles thick, their clubs with two rows of strong hooks, and at the base a rounded group of suckers, with which they are supposed to unite the two tentacles, and use them in conjunction as a *point d'appui*, where great strength is required in capturing their prey. Gladius lancet-form, with a conical commencement.

These animals are solitary in habit, frequenting the open sea, and especially banks of gulf-weed. Some of the species have an immense geographical distribution; as *O. Banksii*, from the Arctic Ocean to the Cape of Good Hope and Indian Ocean. The peculiar arrangement of suckers, forming a circle at the base of each tentacular club, enabling the animal to use the two clubs in conjunction when necessary, give an immense increase of power. They suggested the obstetric forceps of Professor Simpson.

Onychia, Lesueur, 1821.

Syn.—Teleoteuthis, Verrill, 1882.

Distr.—2 sp. W. Indies, Coast of Chili, Indian Ocean. *O. Caribæa*, Les. (xxvi, 41).

Generally like Onychoteuthis; tentacles thin, clubs with two rows of hooks, two rows of suckers, and a circle of suckers at the base for supporting the tentacles together. Gladius feather-like.

Enoploteuthis, d'Orbigny, 1841.

Armed Calamary. Enoplos, armed, and *teuthis.*

Distr.—5 sp. W. Africa, So. Pacific, Mediterranean. *E. Smithsii*, Leach (xxvii, 43). 1 fossil sp. Lithographic stone of the Upper Oxford, Eichstadt, Bavaria.

Body long, cylindrical, with triangular fins either at the end or all along both sides (Ancistrocheirus); arms with two rows of hooks, and with sometimes (Abralia) suckers at their ends; tentacles with hooks only; siphon connected with the head by bands; the fourth right or left arm hectocotylized. Shell feather-like or blade-shaped.

abralia, Gray, 1849. Sessile arms with hooks below, and suckers at the tips. *Distr.*—4 sp. N. Atlantic, Indian O., Messina, Kurile Isles.

ancistrocheirus, Gray, 1849. Fins occupying nearly the whole length of the body. *Distr.*—1 sp. Indian Ocean.

Lestoteuthis, Verrill, 1880.

Syn.—Cheloteuthis, Verrill, 1881.

Distr.—*L. Kamtschatica*, Midd. Kurile Isles.

Tentacular club with numerous suckers and a few large central hooks. Sessile arms dissimilar; lower ones with four rows of suckers; upper with two central rows of hooks, and with marginal suckers on each side. Pen with a long terminal cone.

Verania, Krohn, 1846.

Named for Verany, author of a work on the Cephalopoda of the Mediterranean Sea.

Syn.—Octopodoteuthis, Ruppell and Krohn, 1844.

Distr.—Mediterranean. *V. Sicula*, R. and K. (xxvi, 42).

Body cylindrical, thin, rounded behind, with fins along nearly the whole length; arms with two rows of small hooks; tentacles thin, shorter than the sessile arms, with small suckers; siphon connected by bands. Shell feather-like. Too close to Enoploteuthis.

Octopodoteuthis has priority, but is rejected as inappropriate for a decapod.

PLESIOTEUTHIS, Wagner, 1860.

Distr.—2 sp. Fossil, in the Solenhofen slate: liassic. *P. prisca*, Wagner (xxviii, 66).

Body rather long, attenuated behind; arms with hooks. Shell small, lancet-form, with a central and two side ridges, and an arrow-shaped point. Huxley supposed this genus to belong to the Belemnitidæ, but the gladius showed neither rostrum nor phragmocone.

DORATEUTHIS, Woodward, 1883.

Type.—*D. Syriaca*, Woodward. Cretaceous, Syria.

Arms furnished with suckers and probably also with minute hooklets; the tentacular arms much longer than the sessile ones. Pen nearly as long as the body, the shaft marked by three equidistant ridges, one median and two lateral, which converge together at the very acute distal extremity; there are lateral expansions on each side, corresponding with lateral fins on the body of the animal: the latter is also provided with a terminal fin

The form of the pen as well as that of the animal indicates resemblance to Ommatostrephes.

CELÆNO, Münster, 1842.

Distr.—2 fossil sp. Liassic formation of Solenhofen. *C. conica*, Wagner (xxviii, 61, 62).

Body oval; arms with hooks and suckers. Shell a rounded blade, with winged projections on either side of the pen; nucleus central.

DOSIDICUS, Steenstrup, 1856.

Distr.—The single, unfigured species, was at first believed to have been taken at Marseilles, but it is more probably West Indian.

Body long; arms with large pedunculated suckers on the lower half, and many small ones on the upper, thinner half; clubs of the tentacles with four or five hooks. Shell with a large, nearly solid end-cone.

Perhaps an abnormal specimen, with truncated and partially reproduced arms.

FAMILY OMMATOSTREPHIDÆ.

OMMATOSTREPHES, d'Orbigny, 1835.

Sagittated Calamary. Omma, the eyes, and *strepho*, to turn.

Syn.—Cycria, Leach. Todarodes, Steenst., 1880. Illex, Steenst., 1880.

Distr.—13 sp. Europe, N. Atlantic Coast of U. S., W. Indies, Cape of Good Hope, Antarctic Sea, Pacific Coast of America, Polynesia, Indian Ocean. *O. sagittatus*, Lam. (xxvii, 44, 45). Fossil: pens of 4 sp. in the Oxford clay, Solenhofen (liassic); 1 sp. tertiary.

Body long, cylindrical; arms short, with two rows of suckers; tentacles short, not retractile, the clubs with four rows of suckers; siphon valved, fastened to the head by bands. Shell small, lancet-form, with a hollow end-conus.

These animals are gregarious, frequenting the open sea in all climates. Extensively used as bait in the Newfoundland cod-fishery; they are also the principal food of the albatross, the larger petrels, the dolphins and the cachelots. They are called "sea-arrows" or "flying squids" by fisherman, on account of their habit of darting out of the water, often to such a height as to fall on the decks of vessels. The egg-masses are in large clusters, floating on the surface.

Ommatostrephes illecebrosa was observed among the wharves at Provincetown, Mass., during the month of July, engaged in capturing and devouring the young mackerel, which were swimming about in schools, and at that time were about four or five inches long. In attacking the mackerel they would suddenly dart backward among the fish, with the velocity of an arrow, and as suddenly turn obliquely to the right or left and seize a fish, which was almost instantly killed by a bite in the back of the neck, with the sharp beaks. The bite was always made in the same place, cutting out a triangular piece of flesh, and was deep enough to penetrate to the spinal cord. The attacks were not always successful, and were sometimes repeated a dozen times before one of these active and wary fishes could be caught. Sometimes, after making several unsuccessful attempts, one of the squids would suddenly drop to the bottom, and, resting upon the sand, change its color to that of the sand so perfectly, as to be almost invisible. In this way it would wait until the fishes came back, and when they were swimming close to or over the ambuscade, the squid, by a sudden dart, would be pretty sure to secure a fish. Ordinarily, when swimming, they were thickly spotted with red and brown, but when darting among the mackerel, they appeared translucent and pale. The mackerel, however, seemed to have learned that the shallow water is the safest for them, and would hug the shore as closely as possible, so that in

pursuing them many of the squids became stranded, and perished by hundreds, for when they once touch the shore, they begin to pump water from their siphons with great energy, and this usually forces them farther and farther up the beach. At such times they usually discharge their ink in large quantities. The attacks on the young mackerel were observed mostly at or near high water, for at other times the mackerel were seldom seen, though the squids were seen swimming about at all hours; and these attacks were observed both in the day and evening. But it is probable, from various observations, that this and the other species of squids are partially nocturnal in their habits, or at least are more active in the night than in the day. Those that are caught in the pounds and weirs mostly enter in the night, and evidently when swimming along the shore in schools. They are often found in the morning stranded on the beach in immense numbers, especially when there is a full moon, and it is thought by many of the fishermen that this is because, like many other nocturnal animals, they have the habit of turning toward and gazing at a bright light, and since they swim backwards, they get ashore on the beaches opposite the position of the moon. This habit is also sometimes taken advantage of by the fishermen who capture them for bait for cod-fish; they go out in dark nights with torches in their boats, and by advancing slowly toward a beach, drive them ashore.—VERRILL. *Report of U. S. Fish Commissioner* for 1873, 441.

The following notice of the Squid of the Newfoundland Banks in its relation to the American Grand Bank Cod Fisheries, is condensed from a paper by H. L. Osborn in *Am. Naturalist*, xv, 366, 1881.

The bait used in the latter part of the year is the squid *Ommatostrephes illecebrosa.* It first appears on the southern points of Newfoundland late in June or early in July. The natives and fishermen agree in opinion that the squid migrates steadily northward during the season, appearing first in the northern harbors two weeks later than in the southern, and finally lingering at northern points in the island after they have entirely disappeared from those further south.

The sole mode of capture of the squid is called "jigging," a term derived from and descriptive of the process. The only gear is a peculiar hook with a couple of fathoms of mackerel line. No bait is employed. The jig is of lead, two inches or thereabouts in length, armed at its base with sharply pointed unbarbed pins, radially arranged, and curving upward and outward. The jigging is conducted in water of from eight to ten feet, usually from small boats, but occasionally from the vessel's side. The jig is allowed to sink nearly to the bottom, where it is kept constantly vibrating up and down, till the squid is felt upon it.

Frequently two jigs are managed, one in each hand. The squid merely clasps his tentacles around the jig, and doubtless the pain from the sharp pins induces him to escape instantly, but the fisherman, who is constantly jerking the jig up and down, pulls in as rapidly as possible, entangling the animal's arms among the pins and drawing him through the water so fast that escape is impossible. The instant he emerges from the water he contracts his body, discharging through his siphon a jet of salt water. This is followed by a sucking in of the air by successive respiratory acts, till in its middle portion his cylindrical body has become almost spherical. By a second contraction the squid now ejects from his siphon a stream of his black inky secretion. Not unfrequently the luckless fisherman has not the squid unhooked before this discharge takes place and may receive the inky stream full in the face. The scene when the squid are thick is really exciting; the streams rising here and there, in twenty directions at once, point out the rapidity of the catch, and the monotonous noise of the squirt is only varied by an occasional murmur of discontent from this or that unfortunate as he lifts his querulous voice. The squid usually sell at from twenty-five to forty cents per hundred. The number used by a single vessel in only two months is astonishing. Our vessel, a small one, made three "baitings," fishing each time about two weeks and used in that time 80,000 of the squid.

A species of Ommatostrephes is extensively fished in Japan. Mr. Arthur Adams relates that off Nisi-Bama in the Oki Islands, he saw a number of lights moving upon the surface of the water, in all directions, which he found were used to attract the cephalopods to the surface; where they were secured by a jig, an iron shank terminated by a circle of recurved hooks. Mr. Adams visited a small fishing village near Hakodadi, where he saw hundreds of thousands of squids, cleaned and stretched on bamboo-sticks, suspended on lines to dry in the sun and air.

HYALOTEUTHIS, Gray, 1849. Body transparent, tubercular beneath; one or two cups on the second pair of sessile arms larger. *Distr.*—The only species is from the West Indies.

MOROTEUTHIS, Verrill, 1882. Pen long, narrow, thin, terminating posteriorly in a conical, hollow, many-ribbed, oblique cone, which is inserted into the oblique anterior end of a long, round, tapering, acute, solid cartilaginous terminal cone composed of concentric layers, and corresponding to the solid cone of Belemnites in position and relation to the true pen; elliptical connective cartilages on the base of the siphon; nuchal, longitudinal crests three, much as in Ommatostrephes; eyelids with a distinct sinus; caudal fin large, broad, spear-shaped; ventral arms with smooth-rimmed suckers at the base. Rest of armature unknown. *M. robusta*, Verrill.

STHENOTEUTHIS, Verrill, 1880. (Xiphoteuthis, Owen, 1881.) Distinguished by its large caudal fin, and by having a broad, membranous web along the lower side of the lateral arms, outside the suckers. *O. megaptera*, Verrill, Nova Scotia.

ARCHITEUTHIS, Steenstrup, 1857.

Syn.—Megaloteuthis, Kent; Dinoteuthis, More, 1875. Mouchezia, Vélain, 1878.

Distr.—9 sp. N. Atlantic Ocean, Alaska, Indian Ocean.

A number of gigantic cephalopods, allied to *Ommatostrephes*, have been described and referred to new genera, as above, principally on considerations of size. Verrill says that Architeuthis may be best distinguished from Ommatostrephes by the presence on the club of an irregular group of small, smooth-rimmed suckers, intermingled with rounded tubercles on each arm, the suckers on one arm corresponding with the tubercles of the other, so that by them, the two arms may be firmly attached together and thus used in concert.

In the *Manual of Conchology*, vol. i, pp. 74-91, I have given detailed accounts of some of the enormous squids found principally in the North Atlantic Ocean. The celebrated Kraken, an imaginary sea-monster, doubtless originated in the marvelous tales of an uneducated people who had seen some of these squids: so circumstantial and so well-believed was the account of the Kraken, that Linnæus found a place for it in his "Systema." Scarcely less marvelous are the well-authenticated accounts of some of these monsters encountered in modern times. The following was published in *The Zoologist*, June, 1875:

CAPTURE OF AN ENORMOUS CUTTLE-FISH OFF BOFFIN ISLAND, ON THE COAST OF CONNEMARA (IRELAND).—On Monday last, the crew of a curragh,* consisting of three men, met with a strange adventure northwest of Boffin Island. Having shot their spillets (or long lines) in the morning, they observed to seaward a great floating mass, surrounded by gulls; they pulled out, believing it to be a wreck, but, to their great astonishment, found it to be a cuttle-fish of enormous proportions, and lying perfectly still, as if basking on the surface of the water. A knife was the only weapon on board. The cuttle is much prized as a bait for coarse fish, and the crew resolved to secure at least a portion of it. Considering the great size of the monster, and knowing the crushing and holding powers of the arms, open hostility could not be resorted to, and the fishermen shaped their tactics differently. Paddling up with caution, a single arm was suddenly seized and lopped off. The cuttle, hitherto at rest, became dangerously active now, and set out to sea at full speed in a

* A large kind of coracle made with wooden ribs, and covered with tarred canvas.

cloud of spray, rushing through the water at a tremendous rate. The canoe immediately gave chase, and was up again with the enemy after three-quarters of a mile. Hanging on the rear of the fish, a single arm was attacked in turn, while it took all the skill of the men to keep out of the deadly clutch of the suckers. The battle thus continued for two hours, and while direct conflict was avoided, the animal was gradually being deprived of its offensive weapons. Five miles out on the open Atlantic, in their frail canvas craft, the boatmen still slashed away, holding on boldly by the stranger, and steadily cutting down his powers. By this time the prize was partially subdued, and the curragh closed in fairly with the monster. Such as remained of the ten great arms slashed around through the air and water in most dangerous but unavailing fashion. The trunk of the fish lay alongside, fully as long as the canoe, while in its extremity, the mutilated animal emitted successive jets of fluid, which darkened the sea for fathoms around. The head at last was severed from the body, which was unmanageable from its great weight, and sank like lead to the bottom of the sea. Of the portions of the mollusk taken ashore, two of the great arms are intact, and measure 8 feet each in length, and 15 inches round the base. The two tentacles attain a length of 30 feet. The mandibles are about 4 inches across. The head, devoid of all appendages, weighed about 6 stone, and the eyes were about 15 inches in diameter.

It is evident, from the supine condition of this monster, that it was very sick or in a dying condition when attacked; otherwise, it would have escaped capture readily by diving. Certain exaggerations in the above account are probably due to the ignorance rather than invention of the captors.

In a further account of this animal,* Mr. A. G. More states that:

The tentacles were 30 feet long when fresh (14 and 17 feet can still be made up from the pickled pieces), and a short arm measured 8 feet in length, by 15 inches around the base. The club of the tentacle, nearly 3 feet in length, is occupied in the centre of the palm by two rows of large stalked suckers, nearly 1 inch in diameter, fourteen in each row; an alternating row of fourteen smaller suckers ($\frac{1}{2}$ in. diam.) occupies the margin on each side of the palm; these outer suckers had each a denticulated bony ring of about twenty-eight teeth, pointing inwards (the rings of the larger inner suckers had probably been removed or fallen out before the specimens were examined). Just beneath where the large suckers end, there is a cluster of very small ones arranged closely in six transverse rows, and the extremity of

* *Annals and Mag. of Nat. Hist.*, 4th ser., xvi, 123.

the club has also a great number of small suckers, whilst a few nearly sessile ones are scattered on the inner surface of the peduncle. Most of these had no denticulations on the rings. The beak has a wide, strong tooth about the middle of the edge of the upper mandible, and a much narrower notch on the outer mandible, on each side. These specimens are now in the Museum of the Royal Society, at Dublin.

Several very large cephalopods have been stranded on the coasts of Newfoundland and Labrador, within the past few years; most of them have been well described by Prof. A. E. Verrill.

STEENSTRUPIA, Kirk, 1882. Large, body comparatively slender, cylindrical, very slightly swollen in the middle; caudal fin small, rhomboidal, lateral; head long and narrow; eyes large, round; sessile arms small, all of same size; suckers stalked; internal shell lanceolate, with a hollow conical apex. *S. Stockii*, Kirk, New Zealand.

PLECTOTEUTHIS, Owen, 1881. Folded squid. Suckers upon a relatively broader flattened tract than in Ommatostrephes; back or dorsal side of the arms also with a broad tract, flanked by a thin fold of the integument extending the length of the arm on either side.

Described from a single gigantic arm preserved in the British Museum. The suckers are as in Ommatostrephes. The ventral arms of Architeuthis are similarly fringed, and it is very doubtful whether the characters given by Owen are sufficiently distinctive even for a subgenus. *P. grandis*, Owen (xxiv, 17).

MASTIGOTEUTHIS, Verrill. Body elongated, tapering to a point, confluent with the caudal fin posteriorly. Caudal fin very large and broad, rhomboidal, occupying about half the length of the body. Mantle fastened to the base of the siphon by an ovate, ear-shaped elevated cartilage on each side, fitting into corresponding deep, circumscribed pits on the base of the siphon. Siphon with a bilabiate aperture, an internal valve, and a pair of dorsal bridles. Eyes large, with round pupils; lids free, thin, apparently with a very small anterior sinus. Arms very unequal, the ventral ones much the longest. Suckers small, in two regular rows. Tentacular arms long and round, tapering to the tips, shaped like a whip-lash, without any distinct club; the distal portion is covered nearly all around with exceedingly numerous and minute suckers, which have only a very narrow, naked line along the outside. Pen narrow and bicostate anteriorly, very slender in the middle; posteriorly much larger, with a long tubular cone.

This remarkable squid is distinguished by the character of the tentacular arms and suckers, the pen, the connective cartilages, and simple eyelids. *M. Agassizii*, Verrill (xxiv, 15, 16).

MEGATEUTHIS, Hilgendorf, 1880.

Distr.—*M. Martensii*, Hilg. Japan.

Differs from Ommatostrephes in the greater length of the eight arms, which are longer than the mantle, in the thinness of the tentacular arms, and in the greater width of the pen, which is double that of Ommatostrephes, without rib and somewhat flabby.

Founded on portions of two individuals of a very large cephalopod. The length of one of them, including the outstretched tentacles, was about twenty feet, of which the head and body measured about seven and a half feet.

FAMILY SEPIIDÆ.

SEPIA, Linn., 1758.

Cuttle-fish. Syn.—Palæoteuthis, Rœmer; Sepiella, Gray, 1849.

Distr.—Littoral, world-wide. *S. officinalis*, Linn. (xxvii, 48, 49), *S. elongata*, Orb. (xxvii, 50). 30 species. Fossil: 10 sp. Oxford Clay, Solenhofen; Miocene of Italy.

General characters those of the family (p. 13); under the eyes a lid-like fold, over them lachrymal openings; six aqueous pores in the buccal membrane; arms short; tentacles long; suckers long-pedunculated; siphon with very large valve. Fourth left arm hectocotylized to its base.

A few species are known only by the shell (cuttle-bone); which is a calcareous lamina lodged in the back of the body, very thick in front, concave internally behind; terminating in a prominent mucro. The thickened part is composed of numerous plates, separated by vertical fibres, which render it very light and porous. It was formerly used as an antacid by apothecaries.

The cuttle-fishes live near shore, and the mucro of their shell, d'Orbigny thinks, is intended to protect them in the frequent collisions to which they are exposed in swimming backwards.

According to Verany, this animal prefers rocky localities in the Mediterranean, where it is fished by means of a dredge called a balancelle, and is also taken at night with the trident. During the month of March the fishermen use a living female Cuttle fastened to a rope, or an imitation of one formed of wood, and made attractive to the male sex by being ornamented with bits of glass; this latter enveiglement is called by the Sicilians a Fumedda, and fishing with either of them is very productive and amusing, especially on a moonlight night. These animals may weigh several pounds; their flesh is much esteemed and abounds in the Italian markets at all seasons of the year. Out of the water the Sepia dies quickly, with violent efforts. At Rome the pigment sepia is still manufactured from the ink of this animal.

The chalky thickening of the shell is used as a dentifrice,* and also for modeling metallic objects, its surface receiving an exceedingly accurate impression. Cuttle-bone is a favorite beak-sharpener for caged birds.

The following observations on *Sepia officinalis* were made by Dr. Paul Fischer, in August, 1866, at the aquarium of Arćachon, Gironde, France. Besides the usual glass cases, there are here vast basins with earth bottoms, and of moderate depth, which receive the results of the fishery on the shore itself. Without this commodious arrangement, it would be impossible to preserve living, the very delicate animals.

The fishermen gather the young individuals called *Casserons*, for food. When caught for the aquarium, they are at first placed in the great basins; they show themselves very timid, discharge inky clouds, and hide under floating objects; always shaded, they remain immobile in the horizontal position, nearly touching the earth by their ventral surface. After some days of repose, they are transferred to a glass aquarium.

The normal position of the Sepia is horizontal, the fins undulating gently, the sessile arms joined at their extremities, forming a sort of pyramid or tetrahedon. In this position the appearance of the head and arms is very like that of an elephant's head with the trunk. The tentacular arms remain contracted within the others when in repose; a position difficult to understand, as after death they are found to be more than double the length of the sessile arms. Sometimes the first pair of arms are raised into a vertical position, like antennæ, the others preserving their normal attitude; sometimes, also, the fourth pair of arms drop towards the earth for a few moments, and much elongate themselves.

The coloring of the Sepia is eminently variable; but if the day is clear, the dorsal surface and arms are magnificently striped; the edges of the fins are black, and their superior face is ornamented with spots of the same color. On the back of large individuals is seen two large obscure spots, which vary in intensity and sometimes entirely disappear. The eye is fatigued in following the incessant variation of coloring caused by the constant movement of the pigment cells, and the metallic reflections of the head and arms are glorious beyond human skill to reproduce. The skin is usually smooth; but when the animal becomes irritated, it shows granulations, principally on the head and back. This is accompanied by a retraction of the arms, which appear both shorter and narrower; the extremities no longer touch, but curve slightly. At the same time the colors change, a uniform gray tint takes the place of the striped bands. The approach of

* This manufacture is extensively pursued at Liverpool; as much as 12 cwt. of cuttle-bone arriving at one time for this purpose.

death is equally announced by a change of colors, which grow dull.

The swimming of the Sepia is differently effected, according to the speed required. A moderate progression is equally easy forwards or backwards. When the animal moves forward, the body remains horizontal; the tentacles, united and extended in front, rest on the fourth pair of arms. The Sepia follows in this manner the course of the water, the resistance of which bends the extremities of the united arms. A moderate backward movement is effected in the same manner; but the tentacles are more elongated and their extremities are somewhat parted; the arms are raised to the line of the body. The undulations of the fins commence at the front or rear, according to the direction which the animal takes. This method of swimming, due entirely to the fins, is not slow, for the normal movement of the Sepia is easy, elegant and rapid; but an occasion of disquietude, as the sight of an enemy, or a noise, causes a much accelerated, jerky and retrograde movement. To effect this the animal spreads its arms and suddenly reunites them; whilst the fins, reduced to inaction, are folded upon the ventral face of the body, the posterior extremity of one of them covering that of the other.

This accelerated action is then due to the movements of the arms, which cause a series of extremely rapid progressions, in which, perhaps, the funnel assists by its discharges. It is erroneous to regard the funnel, as some have done, as the principal or only swimming organ of the cephalopods.

The deposition of the eggs occurs some days after fecundation. I have been a witness to the deposition of three or four eggs, but I was not able to distinguish the method of the operation. A female laid about one hundred eggs, about fifty in a corner of the aquarium, and fifty on the opposite side. These eggs were enrolled by their peduncles around the long leaves of *Zostera marina* (xviii, 13, 14). The larger part of the eggs were laid in the night, for I remarked them in the morning for the first time; they were already black.

When the Sepia is laying, she embraces the leaf of Zostera with her tentacles, and a few instants afterwards the egg is attached. The female removed herself but little from her eggs, but she appeared to me to be sick, exhausted; she died three days after having commenced oviposition, and only a few hours after having attached her last eggs.

I found the ovary filled with a considerable quantity of eggs in all stages of development; the most advanced were already furnished with a white and opaque covering, but none of them were black like those attached to the Zosteras. The black color, then, is acquired at the moment of deposition, and it is probably due to a secretion of the glands which surround the oviduct.

The coloration of the eggs has not escaped the observation of Aristotle, but the explanation which he gives is more than doubtful. The very opaque and very dark skin of the excluded egg, later becomes thinner and nearly translucent. At the last period of development, if the skin is torn away and the viteline sack detached, one can introduce to the world, as I have often done, the young Sepia. It swims immediately, and changes color with the greatest facility.

The coloration of the Sepias several centimetres in length is more variable than that of the adults. The zebra-like black bands are not seen, but the general tint changes instantly from gray to wine-brown, to violet, to green. The young Sepias sink into the sand, only showing a part of the back and the head; they swim like the adults, but ascend and descend more frequently.

The eye of the Sepia has a very strange appearance; the dark pupil representing exactly a ω. It is furnished with an upper lid, colored by chromatophores, and a narrower, whitish under lid; there is also a very distinct palpebral sinus.

The sea-water destined for respiration enters the cephalic extremity of the branchial sack, and leaves by the siphon. The alternate movements of the openings of the sack and siphon can be readily seen.

The branchial sack in a number of adult Sepias was dilated from seventy to seventy-two times a minute, but in the young, about an inch long, the inspirations reached 140 in a minute. This result surprised me; it confirms, for animals of variable temperature, the law established for those of fixed temperature, that the number of inspirations is in inverse ratio to the age.

The use of the tentacular arms of the Sepias was absolutely unknown to me until I had the satisfaction to see them in motion on a morning of the month of August (1867). A case of the aquarium had contained for nearly a month a Sepia of medium size, which, during that time, had taken no nourishment. I threw to it a rather large-sized fish (Caranx), which swam towards the retreat of the Sepia—who had hardly perceived it, when, with prodigious celerity and precision, he unrolled and launched forward his tentacular arms, seized the fish and drew it towards his mouth. The tentacular arms then retracted and disappeared, but the sessile arms wrapped themselves closely around the head and anterior portion of the body of the unfortunate fish—which never made a movement after it was caught. The Sepia swam about easily in all directions for about an hour, eating the while; it then let the remains of the fish drop to the bottom of the aquarium, having opened the skull and devoured the brain as well as a portion of the muscles of the back.

The use of the tentacular arms is then no longer doubtful;

they serve for the seizure of food. I have been able to verify this fact a second time in examining the Calamaries—which pursued a troupe of little fishes, capturing them with these members. Moderate forward or backward progression is not due solely to the fins, but is assisted by the expulsion of water from the funnel; if the animal move forward, the funnel is recurved in front, and forms nearly a right-angle with the body; in retrograde movement the siphon becomes horizontal; it is placed to the right or left when the Sepia would turn, and is strongly recurved from front to back when it would mount to the surface of the water.

The variations of form of the siphon are indisputable, and one cannot doubt their influence upon the direction taken by the animal, but the marginal fins are not less useful; their undulations commencing anteriorly when the animal moves forward, and posteriorly in backward movement; they change suddenly as the direction may be varied. The same facts were remarked with regard to the Calamary.

SEPIELLA, Gray, 1849. Cuttle-bone weaker, subcartilaginous, always without either carina or posterior beak. At the posterior part of the bone is a profound subcutaneous pouch, opening by a large pore at the posterior extremity of the mantle between the fins.

HEMISEPIUS, Steenstrup, 1875.

Distr. *H. typicus*, Steenst. (xxvii, 46, 47). Cape of Good Hope.

Differs from Sepia by the sessile arms having only two rows of suckers; the ventral surface of the mantle with aqueous pores situated in little nipples, and connected together by a longitudinal groove. The very rudimentary calcareous partitions of the inner side of the cuttle-bone only cover a portion of the excessively thin plate.

TRACHYTEUTHIS, Meyer, 1846.

Syn. Coccoteuthis, Owen, 1855. Glyphiteuthis, Reuss?

Distr. 3 fossil species from the Jurassic of Europe. *T. hastiformis*, Ruppell (xxviii, 71).

Shell like Belosepia, thickened ventrally by horny, instead of chalky layers.

The shell resembles Sepia in the dorsal side being granulated, but the ventral side is horny instead of chalky; the posterior end has long wing-like expansions.

FAMILY BELOSEPIIDÆ.

BELOSEPIA, Voltz, 1830.

Distr. 5 fossil species. European Eocene. *B. sepioidea*, Blainv. (xxviii, 64, 65).

General characters those of the family. Doubtfully separable from Sepia.

The principal character of the shell or sepiostaire, is the hood of chalky plates which covers the posterior end; these partitions are regularly placed and separated by cavities. The rostrum is thick, turned towards the back; the wing-like extensions of the shell are chalky.

FAMILY BELEMNITIDÆ.

The shell of Belemnites consist fundamentally of:—

1. A hollow cone, the *phragmocone* (ii, 19, 20), with a thin shelly wall, termed the *conotheca*, and which is divided by transverse septa, concave above and convex below, into chambers or loculi; the chambers are perforated near the ventral margin by a *siphuncle*.

2. A *guard* or *rostrum* more or less extensively enveloping the apical part of the phragmocone. "The phragmocone is not a chambered body made to fit into a conical hollow previously formed in the rostrum, as some have conjectured, but both the rostrum and cone grew together; the former was formed on the exterior of a secretive surface, and the latter on the interior of another secretive surface."—PHILLIPS.

The rostrum is composed of calcareous matter arranged in fibres perpendicularly to the planes of the laminæ of growth. Professor Owen describes the fibres as of a trihedral prismatic form, and one two-thousandth of an inch in diameter. These fibres are disposed concentrically around an axis, the so-called apical line, which extends from the extremity of the phragmocone to that of the rostrum. Indications of a thin capsule or formative membrane appear in some Belemnites investing the guard; in those of the Oxford clay it is represented by a granular incrustation; in some liassic species it appears in delicate plaits, like ridges or furrows; in some specimens of *Belemnitella mucronata* from the upper chalk of Antrim, it is in the form of a very thin nacreous layer.

3. A *pro-ostracum*, or anterior shell, which is a dorsal extension of the *conotheca* beyond the end where the guard disappears. The surface of the conotheca is marked by lines of growth, and, according to Voltz, it may be described in four principal regions radiating from the apex; one dorsal, with loop lines of growth, advancing forward; two lateral, separated from the dorsal by a continuous straight or nearly straight line, and covered with very obliquely arched striæ in a hyperbolic form, in part nearly parallel to the dorso-lateral boundary line, and in part reflexed, so as to form lines in retiring curves across the ventral portion nearly parallel to the edges of the septa. There were at least three kinds of pro-ostracum in the family Belemnitidæ.

A. In many Belemnites the extension of the *conotheca* seems to run out in one simple broad plate, as in *B. hastatus*, from Solenhofen (ii, 22).

B. In *Belemnites Puzosianus*, d'Orbigny, the pro-ostracum is very thin, and apparently horny or imperfectly calcified in the dorsal region, supported laterally by two long, narrow, parallel, calcareous plates (*B. Puzosianus* from the Oxford clay, ii, 20). Professor Huxley considers this difference between the pro-ostraca of generic importance.

C. The third kind of pro-ostracum is exhibited by *Orthoceras elongata*, De la Beche, the type of the genus Xiphoteuthis, Huxley. It is calcareous, and is composed of concentric lamellæ, each of which consists of fibres disposed perpendicularly to the plane of the lamella; the phragmocone is very long and narrow, and the guard cylindroidal.

Professor Huxley suspects that a thoroughly well-preserved specimen of Belemnoteuthis will some day demonstrate the existence of a fourth kind of pro-ostracum among the Belemnitidæ.

"The Acanthoteuthes of Munster, so far as they are known only by hooks and impressions of soft parts, may have been either Belemnites, or Belemnoteuthis, or Plesioteuthis, or may have belonged to the genus Celœno."—HUXLEY.

The genus Belopeltis, Voltz, was founded on the pro-ostraca of Belemnites.

The genus Actinocamax, Miller, was founded on the guards of Belemnites and Belemnitella, the upper parts of which had decayed, and thus presented no alveolar cavity.—WOODWARD.

BELEMNITES, Lamarck.

Etym.—*Belemnon*, a dart.

Syn.—Diploconus, Zittel, 1868. Actinocamax, Voltz, 1840. Gastrosiphites, Notosiphites and Pseudobelus, Duval.

Distr.—100 sp., fossil only. *B. excentricus*, Keferst. (xxviii, 72).

Animal, arms and tentacles with two rows of horny hooks. Shell, phragmocone horny and slightly nacreous, with a minute globular initial chamber; two nacreous bands on its dorsal side, and produced beyond its rim into sword-shaped processes, represent the rostrum, which is fibrous, cylindrical, thickened behind, thin in front where it invests the phragmocone.

These animals, supposed to have been gregarious, from the number of their remains found in certain localities, were very numerous in species, over 100 having been described from the liassic and chalk formations of Europe, from the chalk of Southern India, from the Jurassic of the Himalayas, etc.

The phragmocone is very delicate, and its preservation is usually due to the infiltration of calcareous spar into its chambers. M. d'Orbigny supposes that the variation of the propor-

tions of the guard, as compared with the phragmocone, being sometimes only a half-inch longer than the latter, and sometimes one or two feet, depends partly on age and sex.

D'Orbigny has presented the following scheme of sections and subsections for dividing the large number of species of Belemnites; they have been generally adopted.

SECTION I. ACŒLI (Bronn.), guard without dorsal or ventral grooves.

Subsection 1. *Acuarii*, without lateral furrows, but often channeled at the extreme point. *B. acuarius.* 20 species. Lias—Neocomian.

Subsection 2. *Clavati*, with lateral furrows. *B. clavatus.* 3 species. Lias. (Includes the genera Pachyteuthis, Megateuthis and Dactyloteuthis, Bayle.)

SECTION II. GASTROCŒLI (d'Orb.), guard with ventral groove distinct.

Subsection 1. *Canaliculati*, no lateral furrows. *B. canaliculatus.* 5 species. Inferior oolite—Great oolite.

Subsection 2. *Hastati*, lateral furrows distinct. *B. hastatus.* 19 species. Upper lias—Gault. (Includes the genera Cylindroteuthis, Belemnopsis and Hibolites, Bayle.)

SECTION III. NOTOCŒLI (d'Orb.), guard with a dorsal groove, and furrowed on each side. *B. dilatatus.* 9 species. Neocomian. (Genus Duvalia, Bayle.)

HELICERUS, Dana, 1848.

Distr.—1 fossil species (*H. Fuegiensis*, Dana, xxix, 87), in slate rock, Cape Horn.

Shell like Belemnites, half-inch in diameter; guard thick, subcylindrical, fibrous; phragmocone slender, terminating in a fusiform spiral nucleus.

BELEMNITELLA, d'Orbigny, 1840.

Syn.—Atractites, Link, 1867.

Distr.—6 fossil species. Cretaceous; N. Am. and Europe. *B. mucronata*, Sowb. (xxviii, 70).

Rostrum with a straight fissure on the ventral side of its alveolar border; its surface with distinct vascular impressions. Casts of the alveolus show that the phragmocone was chambered, had a single dorsal ridge, and a ventral process entering the fissure of the rostrum.

XIPHOTEUTHIS, Huxley, 1864.

Distr.—*X. elongata*, Beche (xxviii, 68). Liassic, England.

Rostrum and pro-ostracum calcareous, phragmocone very long and narrow.

Acanthoteuthis, Wagner, 1839.

Etym.—*Acantha*, a spine, and *teuthis*, a calamary.

Syn.—Belemnosepia, Desh.; Belemnoteuthis, Pearce, 1842; Kalæno, Münster, 1836.

Distr.—17 fossil sp. Oolitic. *A. antiquus*, Cunn. (xxviii, 74).

Animal with ten nearly equal arms with two rows of horny hooks and suckers; margin of mantle free all around; fins large, medio-dorsal. Shell a phragmocone like Belemnites, a horny dorsal pen with obscure lateral bands and a thin fibrous rostrum with two diverging dorsal ridges.

Conoteuthis, d'Orbigny, 1842.

Distr.—*C. Dupinianus*, Orb. (xxviii, 69). Neocomian, France.

Phragmocone slightly curved, chambered and siphunculated, with an elongated, slender pen. No protecting rostrum.

Belemnosis, Edwards, 1849.

Distr.—*B. plicata*, Edwards (xxviii, 86). Eocene, London.

Phragmocone straight or slightly curved; rostrum rather long, thickened dorsally and obtuse at the hinder end, with a ventral opening.

Beloptera (Deshayes), Blainv., 1825.

Etym.—*Belos*, a dart, and *pteron*, a wing.

Syn.—Belopterina, Munier-Chalmas, 1872. Vasseuria, Munier-Chalmas, 1880. Bayanoteuthis, Munier-Chalmas, 1871.

Distr.—4 fossil species. Eocene of Paris and Bracklesham. *B. belemnitoides*, Blainv. (xxviii, 80).

Shell straight, rostrum sometimes winged on the sides, bluntly beaked at the hinder end.

Spirulirostra, d'Orbigny, 1841.

Dist.—*S. Bellardii*, d'Orb. (xxix, 81). Tertiary of Turin.

Phragmocone commencing with a spiral like Spirula, afterwards continuing straight; external spathose layer produced posteriorly into a long, pointed end.

Family SPIRULIDÆ.

Spirula, Lamarck, 1799.

Syn.—Ammonia, Breyn., 1732.

Distr.—3 species, all tropical seas. *S. Peronii*, Lam. (xxvii, 51–53).

Body oblong, with minute terminal fins. Mantle supported by a cervical and two ventral ridges and grooves. Arms with six rows of very minute cups. Tentacles elongated. Funnel valved.

Shell placed vertically in the posterior part of the body, with the involute spire towards the ventral side.

Although thousands of shells of these mollusks are washed ashore in all parts of the world, the animal is almost unknown, but three perfect individuals, and several others, more or less imperfect, having been collected. The U. S. Coast Survey Steamer Blake, in 1878, dredged a Spirula with its mollusk, in the West Indies, at the great depth of 950 fathoms. Prof. Owen's last memoir on the Spirula adds materially to what was heretofore known respecting it. (*Ann. Mag. Nat. Hist.*, 5 ser., iii, 1, 1879.) He shows that the mantle terminates posteriorly in two lateral flaps which cover the sides of the shell, leaving it partly exposed dorsally and ventrally. Posteriorly, between the lobes, is an elliptical, convex body, with a central depression or disk, flanked by a pair of oblong productions, perhaps homologous with fins, or at any rate resembling the small lateral-terminal fins of *Loligopsis*. The terminal disk is, perhaps (as long ago described by Rumphius), a true sucker, enabling the animal to attach the posterior end of its body to any object, leaving the arms free to exercise their prehensile power on passing objects of food. This wonderful terminal sucking organ is not found in any other cephalopods, but may have been possessed by the animal of Ammonites, supposing it to have been related to the Spirula rather than the Nautilus. The anatomy of Spirula, which is carefully worked out and illustrated in Prof. Owen's memoir, shows it to belong to the dibranchiate decapod cuttle-fishes, as already indicated by previous studies. Whilst Spirula possesses natatory powers superior to the Nautilus, in the action of its webbed arms, additional to that of the funnel, the former are so small in proportion to the size of the animal, and the fins are so rudimentary as to indicate sedentary habits. Prof. Owen observes that in Spirula, as in Nautilus, "the shell serves as the *point d'appui* of the retractors of the funnel and of the head with its locomotive and prehensile organs. Moreover, the last chamber of the shell in Spirula also receives part of the visceral mass, viz., the hind termination of the liver, which, covered by its capsule, and this again by the peritoneum or a delicate aponeurosis continued from the attached shell-muscles, constitutes the hemispheric mass that fills the chamber and forms or sends off the beginning of the membranous siphon.

In another memoir, Prof. Owen shows that the dorsal portion of the animal of Spirula is placed towards the outer wall of the shell, which is the reverse of the relative positions of animal and shell in both Nautilus and Ammonites, showing that the spiral growth of the shell cone took a contrary direction. He agrees that the aptychi are developed on the spadix of Ammonites, and are true opercular bodies; consequently the Ammonite could

not have been like the Spirula, an internal shell, but must have been closely related to Nautilus.*

According to some recent investigators, there is a marked resemblance between the recent Spirula and the fossil Ammonites, particularly in the initial whorl, and a difference in the latter character between Ammonites and Nautilus which is thought to indicate that the Ammonites should be separated from the tetrabranchiate and united with the dibranchiate cephalopods. If this should prove to be so, then the Spirula will assume a new importance to us as the last vestige of a numerous group, else extinct.

In *Proc. Zool. Soc.*, London, 1880, Prof. Owen describes and figures a male Spirula. The ventral pair of arms are modified for the sexual purpose, but are not hectocotylized, having lost all trace of acetabular organization.

ORDER II. TETRABRANCHIATA.

FAMILY NAUTILIDÆ.

Septa simply curved, concave on the outer face, sutures simple, or undulate or lobed; mouth simple; siphonal opening nearly central. Shell but little sculptured, or smooth.

Six living and over 2000 fossil species.

FAMILY AMMONITIDÆ.

Septa convex in their median section, sutures complex, lobed, ramified or denticulated; septal tube cylindrical and always directed forwards; siphuncle cylindroid, small, marginal, the siphonal investment more or less solid and persistent. Fossil only, several thousand species known.

Nearly 5000 fossil species of cephalopod shells have been referred to the tetrabranchiates, although it has been recently suspected that at least a large portion of these were internal shells like the Spirulas and referable therefore to the dibranchiata. Only a half-dozen recent species are known, all belonging to the genus Nautilus.

The tetrabranchiate shell is essentially an elongated cone, divided off into chambers by partitions, and siphunculated. These septa have simply curved edges in Nautilus and Orthoceras, they are zigzag in Goniatites, or foliaceous, forming complicated lobes in Ammonites. The shell may be straight, curved, open or close spiral, and even vary in form at different ages, and these variations, when well understood, will doubtless cause a

* Owen, on the Relative Positions to their Constructors of the Chambered Shells of Cephalopods. *Zool. Proc.*, 955, 1878.

large reduction to be made in the number of generic forms at present accepted. The following synopsis will exhibit these variations in some of the more important genera.

Form of Shell.	Nautilidæ.	Ammonitidæ. With undulating sutures.	Ammonitidæ. Sutures toothed at the base.	Ammonitidæ. Sutures complex lobed or foliaceous.
Straight	Orthoceras		Baculina.	Baculites.
	Bactrites			Rhabdoceras
	Gomphoceras			
Bent or curved	Cyrtoceras			Toxoceras.
	Phragmoceras			
Discoidal spire and free whorls	Ascoceras			
	Gyroceras			Cryoceras.
Ibid. Finally straight or hook-shaped	Lituites			Ancyloceras.
Hook-shaped or bent upon itself more than once, whorls free				Hamites.
Ibid. Straight portions in contact				Ptychoceras.
Involute, spiral	Nautilus	Goniatites	Ceratites.	Ammonites.
	Nothoceras			
		Clymenia		
				Clydonites.
Involute; last chamber detached, hook-shaped				Scaphites.
Elongated, spiral, whorls in contact				Turrilites.
				Cochloceras.
Spiral, elongated, whorls not in contact	Trochoceras			Helicoceras.
Spiral, elongated, the last whorl free, produced and recurved.				Heteroceras.

Family NAUTILIDÆ.

Orthoceras, Breynius, 1732.

Etym.—*Orthos*, straight, and *ceras*, a horn.

Syn.—Actinoceras, Bronn, 1835. Orthoceratites, Breyn. Jovellania, Bayle, 1878. Cycloceras and Loxoceras, M'Coy, 1844.

Distr.—Fossil, 1200 sp. L. Silurian to Triassic; N. America, Australia, Europe. *O. subannulare*, Barr. (xxix, 79). *O. planicanaliculatum*, Sandb. (xxviii, 67).

Shell straight, aperture sometimes contracted.

Probably the animal was not able to withdraw itself completely

into its shell, as in the *Nautilus*. That the shell was external is indicated by the colored bands preserved on *O. anguliferus*. These shells sometimes grew to a great size; a specimen in the collection of Mr. Tate of Alnwick, England, must have been six feet long when perfect. Newberry, in the Palæontology of Ohio, estimates another species, *O. Titan*, to have weighed "some tons." The aperture is sometimes so contracted that species two feet in length have a diameter of only one inch at the mouth.

CAMEROCERAS, Conrad, 1842. (Melia, Fischer; Sannionites, Fischer.) Siphuncle lateral, sometimes very large (simple?). Casts of the large siphuncles were called Hyolites by Eichwald. *Distr.*—27 sp. L. Silurian to Triassic (?); N. America, Europe.

ACTINOCERAS (Brown), Stokes. Siphuncle very large, inflated between the chambers and connected with a slender central tube by radiating plates. 6 sp. L. Silur. to Carb.; N. America, Europe. *O. Richardsoni*, Stokes (xxix, 78).

ORMOCERAS, Stokes, 1838. Siphuncular beads constricted in the middle, so that the septa appear as if united to the centre of each. Probably identical with Actinoceras. *Distr.*—3 sp. L. Silurian to Devonian; N. America. *O. Bayfieldi*, Stokes (xxix, 84).

HURONIA, Stokes, 1823. (Discosurus, Hall, 1852.) Shell extremely thin, membranous or horny (?). Siphuncle very large, central, upper portion of each joint inflated, connected with a small central tube of radiating plates. Usually the siphuncle only is preserved. Dr. Bigsby observed specimens six feet in length. Doubtfully distinct from Actinoceras. *Distr.*—3 sp. L. Silurian; Drummond Isl., Lake Huron. *H. vertebralis*, Stokes (xxix, 85).

AULACOCERAS, Hauer. Shell much thickened, longitudinally furrowed, with two deep lateral sulcations; siphon very small, marginal. *Distr.*—4 sp. Upper Triassic; Austria.

BATHMOCERAS, Barrande, 1865. Part of the body-chamber occupied by imbricating plates, decreasing in horizontal extension from below upwards; siphuncle a series of superimposed funnel-shaped tubes. *Distr.*—4 sp. Silurian; Bohemia, Sweden, Lake Huron.

ENDOCERAS, Hall, 1847. (Conotubularia, Troost; Diploceras, Conr.) Shell extremely elongated, cylindrical. Siphuncle very large, cylindrical, lateral; thickened internally by repeated layers of shell, or partitioned off by funnel-shaped diaphragms. *Distr.*—12 sp. L. Silurian; New York, Europe.

TRETOCERAS, Salter, 1858. (Diploceras, Salter, not Conrad, 1856; Nothoceras, Eichw., 1859.) Founded on *O. bisiphonatum*, Sowb. (xxx, 93), from the Caradoc sandstone (Silurian), Brit., in which the septa are apparently perforated by two siphuncles; one of which is a deep lateral cavity continuous with the terminal

chamber—the cavity affecting at least seven of the uppermost septa, if not the whole.

THISOA, Montf. Shell ovate-elongate, cucumber-shaped; apparently two siphons running parallel the whole length of the shell, one of which traverses a sort of narrow lateral cavity; there are also a number of false siphons or holes, which do not extend the entire length of the shell. *T. siphonalis*, Serres (xxix, 82, 83). Jurassic; France.

GONIOCERAS, Hall, 1847. Shell flattened, with extremely salient angles; septa sinuous; section of shell, an extended ellipse with projecting angles; siphuncle ventral. *G. anceps*, Hall (xxx, 94, 95). L. Silurian; N. America.

COLPOCERAS, Hall. This is probably only a siphon of one of the larger species of Orthocerata. *C. virgatum*, Hall (xxx, 96). L. Silurian; New York.

DICTYOCERAS, Eichw., 1859. Is probably an Orthoceras covered by a bryozoan or coral.

TREMATOCERAS, Whitfield. Tube, septa and siphuncle like Orthoceras, but with a line of elongated, raised tubercles along one side of the shell, which have formed perforations at certain stages of growth, probably confined to the outer chamber as openings, which were closed as the animal extended the shell, and before the septa opposite them were formed. Type *T. Ohioense*, Whitfield. Upper Helderberg group, Ohio.

[POLORTHUS, Gabb, 1861.

The aggregated mass of specimens forming the type of this genus was originally referred to Teredo; subsequently, in describing the genus, Mr. Gabb referred it to Vermetidæ, and in 1872 he finally believed it to be a cephalopod connecting the Orthoceratidæ with Beatriceæ. The aggregate character, the long, narrow, irregular tube, the non-molluscan character of the partitions forbid this determination. I am convinced that Polorthus is not a mollusk, and Beatricea itself is now referred, doubtfully, to the sponges.]

CLINOCERAS, Mascke, 1876.

Distr.—*C. dens*, Mascke (xxviii, 73). Erratic L. Silurian blocks; Prussia.

Shell conical (allied to Loxoceras, M'Coy), the siphuncle side straight, the others more or less curved; a constriction below the body-chamber. Septal border with an obtuse-angled saddle on the siphuncle side, with gently rounded lobes and two slightly marked lateral saddles.

BACTRITES, Sandberger, 1842.

Syn.—Stenoceras, d'Orb, 1850.

Distr.—13 sp. Silurian to Trias.; Germany, etc. *B. gracilis*, Sandb. (xxxii, 22). Nassau.

Shell straight, conical; a small sutural lobe corresponds to the marginal siphon.

PILOCERAS, Salter, 1859.

Etym.—*Pilos*, a cap, and *ceras*, a horn.

Distr.—Fossil, 3 species. L. Silurian; Canada, Scotland (Ideal section, xxx, 97).

Shell broad, conical, subcylindrical or compressed, slightly curved. The siphuncle and septa represented by a series of conical septa, concave to a central point. Closely related to Cyrtoceras.

CYRTOCERAS, Goldfuss, 1832.

Etym.—*Curtos*, curved, *ceras*, a horn.

Syn.—Aploceras, d'Orb., 1850. Campulites, Desh. (part), 1832. Campyloceras and Trigonoceras, M'Coy, 1844.

Distr.—Fossil, 350 species. L. Silurian to Carb.; N. and S. America, Europe. *C. acuticostatum*, Sandb. (xxx, 98).

Shell curved; siphuncle small, subcentral.

Seems to differ but little from Orthoceras.

ONCOCERAS, Hall, 1847. (*Oncos*, a protuberance, *ceras*, a horn.) Anterior half of the shell inflated, aperture more or less strangulated. This may possibly = Phragmoceras, Brod. *Distr.*—3 sp. Silurian; New York. *O. constrictum*, Hall (xxx, 997).

CYRTOCERINA, Billings, 1865. Shell short and thick, with a large siphuncle, placed externally. *Distr.*—2 species. Silurian; Canada.

STREPTOCERAS, Billings, 1865. Shell like Oncoceras, but the aperture trilobed. 2 species. Middle Silurian; Canada.

GOMPHOCERAS, J. Sowb., 1839.

Etym.—*Gomphos*, a club, and *ceras*, a horn.

Syn.—Apioceras, Fischer, 1844. Poterioceras, M'Coy, 1844. Mesoceras, Barrande, 1877. Bolboceras, Fischer, 1844. Nelimenia, Casteln., 1843.

Distr.—100 sp. L. Silurian to Carb.; Europe, N. America. *G. pyriforme*, Murchison (xxx, 100). Silurian; England. *G. Bohemicum*, Barr. (xxx, 1). Aperture.

Shell fusiform or bottle-shaped, straight, swollen anteriorly; aperture contracted in the middle; siphuncle subcentral; septa simple, concave.

SYCOCERAS, Pictet, 1854.

Distr.—Silurian, Devonian. *S. orthogaster*, Sandb. (xxx, 21).

Shell oval or bottle-shaped, straight; septa simple; siphuncle marginal.

The position of the siphon varies so much in this group, that it is an insufficient character to distinguish the genus from Gomphoceras.

Ascoceras, Barr., 1847.

Etym.—*Ascos*, a leather bottle, *ceras*, a horn.

Syn.—Cryptoceras, Barr., 1846.

Distr.—16 sp. L. and U. Silurian; Europe, Canada. *A. Bohemicum*, Barr. (xxx, 3).

Shell flask-shaped; the terminal chamber not only fills the front of the shell, but extends down the dorsal side, nearly its whole length, as a deep cavity, which is embraced by the decurrent edges of the four or five incomplete septa; a minute siphuncle on the ventral side.

Glossoceras, Barr., 1865.

Etym.—*Glossa*, a tongue, *ceras*, a horn.

Distr.—2 sp. M. and U. Silurian; Anticosti; Bohemia.

Shell like Ascoceras, but the ventral margin of the aperture ligulately extended and incurved.

Aphragmites, Barr., 1865.

Etym.—*A*, without, *phragmos*, a partition.

Distr.—2 sp. U. Silurian; Bohemia.

Shell like Ascoceras, but the septa are deciduous.

Phragmoceras, Brod., 1839.

Etym.—*Phragmos*, a partition, and *ceras*, a horn.

Syn.—Campulites, Desh. (part), 1832; Phragmolites, Conr., 1838.

Distr.—50 sp. Silurian to Devonian; Europe, N. America. *Ph. ventricosum*, Murch. (xxx, 4). Silurian; England. *Ph. callistoma*, Barr. (xxxi, 6). Aperture.

Shell compressed on the sides, curved; aperture contracted in the middle; last chamber large; siphuncle dorsal, with radiations; septa simple.

Gyroceras, de Koninck, 1844.

Syn.—Nautiloceras, d'Orb, 1847. Polycronites, Troost (?), 1840.

Distr.—40 sp. Silurian to Triassic (?); Europe, N. America. *G. Goldfussii*, Arch. (xxxi, 7). Devonian; Eifel.

Shell planorboid, with separated whorls; septa simple, but little curved; siphuncle excentric, with radiations; last chamber large; mouth but little contracted.

Nothoceras, Barr., 1856.

Distr.—*N. Bohemicum*, Barr. (xxx, 5; xxxi, 8). U. Silurian; Bohemia.

Shell nautiloid, slightly involute; septa but little curved, not lobed.

HERCOCERAS, Barr., 1865.

Etym.—*Erkos*, a wall, *ceras*, a horn.

Distr.—2 sp. Middle Silurian, Bohemia; Devonian, Nassau (?).

Shell generally nautiloid, the whorls sometimes separated, or even turbinate; body-chamber with a diaphragm perpendicular to the axis of the shell, the concavity of which is opposed to that of the last septum, throwing the aperture on the deeply excavated dorsal side of the shell; siphuncle ventral, cylindrical, inflated between the chambers, separated from the shell.

LITUITES, Breyn., 1732.

Etym.—*Lituus*, a trumpet.

Syn.—Trocholites, Emmons, 1842. Palæonautilus and Palæoclymenia, Remelé.

Distr.—28 sp. Silurian; Europe, North America. *L. simplex*, Barr. (xxxi, 9).

Shell planorbiform, the whorls close or separate; the last chamber produced in a straight or outwardly curved line; lateral margins of the aperture extended and curved towards the interior of the shell, contracting the aperture into two distinct orifices.

OPHIDIOCERAS, Barrande, 1867. *Etym.*— *Ophiodes*, serpent-shaped, *ceras*, a horn. Shell with the produced portion very short or wanting. *Distr.*—7 sp. Silurian; Norway, Bohemia..

STROMBOLITUITES, Remelé, 1881. Shell commencing as a small spiral, expanding into an obconic form. L. Silurian; Germany. *S. Torelli*, Remelé (xxix, 90).

HORTOLUS, Montf., 1808. Whorls not in contact.

DISCOCERAS, Barrande, 1867.

Etym.—*Diskos*, a quoit, *ceras*, a horn.

Distr.—3 sp. Middle Silurian; Russia, Germany, Norway.

Shell planorbiform; produced portion very short or wanting; aperture simple, not contracted.

M. Barrande describes this as a subgenus under his genus Lituunculus; of which no species have been observed, but which he creates by anticipation with the diagnosis: "Shell like Lituites, but with a simple aperture," in order that Discoceras may hold the same relationship to it that Ophidioceras does to Lituites! This is filling up the "gaps" with a vengeance, and could scarcely have been predicted of the renowned Bohemian anti-developmentalist.

PTERONAUTILUS, Meek, 1867.

Etym.—*Pteron*, a wing, and *Nautilus*.

Distr.—*P. Seebachianus*, Geinitz (xxxi, 10). Permian.

Shell spiral, involute, finally produced, with lateral wing-like expansions.

SUBCLYMENIA, d'Orb, 1850.

Distr.—*S. evoluta*, d'Orb (xxxi, 12, 13). Devonian; England.

Shell spiral, planorbiform; sutures of septa sinuous, not angular on the sides, but with a single dorsal lobe.

TROCOCERAS, Barr., 1847.

Distr.—60 sp. L. Silurian to Devonian; Bohemia, France, North America.

Shell depressed, spiral, nautiloid or nearly discoidal; whorls free; septa simple. Very closely related to Lituites.

NAUTILUS, Breyn., 1732.

Syn.—Angulites, Montf., 1810; Omphalia, De Haan.

Distr.—6 living species, tropical seas; and nearly 300 fossil species, commencing with the Silurian. *N. Pompilius*, Linn. (iv, 62, 63; xxvii, 54).

Shell involute or discoidal, few-whorled; septa concave, simple; siphuncle nearly central.

Outer surface smooth in the recent species, but corrugated in some of the fossil ones.

Animal placed with its ventral face to the convex (dorsal) wall of the shell.

They are divided into the following groups:

1. Lævigati. Shell smooth. Permian—Living.
2. Radiati. Shell transversely ribbed. Principally cretaceous.
3. Striati. Shell longitudinally striate. Oolite of Europe, and Lower Chalk, India.

Respecting the habits of the Nautilus very little is known: the specimen dissected by Prof. Owen had its crop filled with fragments of a small crab. Rumphius states that "when the Nautilus floats on the water, he puts out his head and all his tentacles, and spreads them upon the water, with the poop of the shell above the surface; but at the bottom, he creeps in the reverse position, with his boat above him, and with his head and tentacles upon the ground, making a tolerably quick progress. He keeps himself chiefly upon the ground, creeping also sometimes into the nets of the fishermen; but after a storm, as the weather becomes calm, they are seen in troops, floating on the water, being driven up by the agitation of the waves. This sailing, however, is not of long continuance; for having taken in all their tentacles, they upset their boat, and so return to the bottom."

The shell is composed of two layers—the outer one porcellanous, the inner pearly; and the Chinese avail themselves of this circumstance to produce elegant relieved carvings upon the pearly layer. Specimens are frequently imported for sale.

During the voyage of the *Challenger*, a living *N. Pompilius* was dredged in three hundred and twenty fathoms, off Matuka

Island, Fiji group. It was very lively, swimming around in a tub, in a retrograde direction, by the ejection of water from the funnel. The tentacles were extended radially from the head, somewhat like those of a sea anemone; but each pair had its definite and different direction, which was constantly maintained; thus one pair of tentacles was held pointing directly downwards, two other pairs, situate just before and behind the eyes, were held projecting obliquely outwards and forwards, and backwards respectively, as if to protect the organs of sight.

The natives of the New Hebrides, New Caledonia, and the Fiji group of islands, capture the Nautilus, and use it as an article of food. They take them in their fish-falls, in from three to five fathoms of water; the bait they use is the echinus. They are very fond of them. In some of the islands they make a kind of soup of them. At the Island of Ware, about 30 miles from New Caledonia, they are roasted, and taste like whelks (Buccinum).

The Fijians esteem the Pearly Nautilus highly as an agreeable viand, and their mode of capturing it for the embers or the pot is not a little interesting. When the water is smooth, so that the bottom at several fathoms of depth, near the border of the reef, may be distinctly seen, the fisherman in his little frail canoe scrutinizes the sands and the coral masses below, to discover the animal in its favorite haunts. The experienced eye of the native may probably encounter it in its usual position, clinging to some prominent ledge, with the shell turned downwards. The tackle consists, first, of a large round wicker-work basket, shaped very much like a cage rat-trap, having an opening above, with a circlet of points directed inwards, so as to permit of entry, but preclude escape; secondly, a rough piece of native rope, of sufficient length to reach the bottom; and thirdly, a small piece of branched wood, with the branches sharpened to form a sort of grapnel, to which a perforated stone is attached, answering the purpose of a sinker. The basket is now weighted with stones, well-baited with boiled cray-fish, and then dropped gently down near the victim. The trap is now either closely watched, or a mark is placed upon the spot, and the fisherman pursues his avocation upon other parts of the reef, until a certain period has elapsed, when he returns, and in all probability finds the Nautilus in his cage feeding upon the bait. The grapnel is now carefully let down, and having entered the basket through the opening on top, a dexterous movement of the hand fixes one or more of the points or hooks, and the prize is safely hoisted into the canoe.

The Pearly Nautilus is not found at the Navigator group of islands in the South Seas, and the shells form there an important article of exchange. They are brought by European vessels from New Caledonia and the Fiji Islands as articles of trade, and are

bartered with the natives at the rate of four for a dollar or one shilling each. I am told it is indifferent to the natives if the shells are old or rather damaged, as they use the chambered portions for ornament, rubbing them down to suit the various purposes to which they apply them. They also make armlets and other ornaments from the shell. A vessel arrived at Sydney from New Caledonia with several tons of these shells, which were disposed of as an article of trade to the Navigator and Friendly Islands; they were sold at Sydney at about $1\frac{1}{2}d.$ each.

I have seen a very elegant fillet formed of these shells (of very small size), brought from the Samoan Islands, the brilliancy of which was that of the most highly burnished silver. They are used by the natives in war, and are highly valued; this one costing twenty dollars. The shells are fixed to a small midrib of cocoanut leaf, which supports them on a worked band of sinnet; upon this, under the row of seventeen shells, small pieces of the same pearly shell were placed to add to the ornamental effect. The length of the band was 12 inches (not including the tying strings) and the depth 3 inches.—DR. GEORGE BENNETT, *Proc. Zool. Soc.*, 226, 1859.

In India elegant drinking cups are made of *Nautilus Pompilius*, the exterior coating being relieved by carving on the inner pearly lamina; or it is sometimes grotesquely painted. Cameo carving on the shell of the Nautilus is extensively practiced in England and other countries, and shells thus prepared are highly valued as ornaments.

ATURIA, Bronn, 1838. (Megasiphonia, d'Orb., 1847.) Sutures of septa with a deep lateral lobe; siphuncle on the concave or inner side of the shell, large, continuous, like a succession of funnels. *Distr.*—6 sp. Eocene, Miocene; N. America, Europe, India. *A ziczac*, Sowb. (xxxi, 14, 16).

DISCITES, M'Coy, 1825. Whorls all exposed; last chamber sometimes produced. *Distr.*—5 sp. L. Silurian, Carb.

TEMNOCHEILUS, M'Coy, 1844. (Endolobus, Meek and Worthen, 1866.) Shell carinated, with an open, conical umbilicus. *Distr.* —5 sp. Carb. limestone *N. biangulatus*, Sowb. (xxxi, 15).

TREMATODISCUS, Meek and Worthen, 1861. Like Temnocheilus, but outer side of whorls with revolving angles and sulci, and frequently, revolving striæ. *Distr.*— Carboniferous; Europe, America. *N. trisulcatus*, Meek and Worthen (xxxi, 17, 18). Subcarboniferous; Rockford, Ind.

CIMOMIA, Conrad, 1866. Septa sinuous, double waved or sigmoid, numerous; siphon small, central. *N. Burtoni*, Galeotti. Lower Eocene.

HERCOGLOSSA, Conrad, 1866. (Aganides, Montf.?) Septa angular and linguiform; apex of the angle or tongue-shaped lobe not contiguous with the adjacent septum; siphon large or moderate,

situated within the centre, or between the middle and the inner margin, and not funnel-shaped, but tubular and gradually tapering. *Distr.*—Eocene, Cret.; Europe, America.

A very doubtful group, as Conrad includes species having respectively the characters of Aturia and of Nautilus; the type species is *N. orbiculatus*, Tuomey.

PSEUDONAUTILUS, Meek, 1876. Differs from Hercoglossa in the septa being provided with well-defined peripheral and anti-peripheral lobes and the siphuncle placed near the outer margin. *Nautilus Geinitzi*, Oppel.

CRYPTOCERAS, d'Orb., 1847. (Solenochilus, Meek and Worthen, 1877.) Planorbiform; septa arcuated, without lobes or sinuosities; siphon dorsal. *Distr.*—2 sp. Devonian, Carboniferous; Europe. *C. subtuberculatus*, d'Orb. (xxxi, 504).

Beaks of Tetrabranchiates.

These are found associated with fossil Nautili and occasionally Belemnites, but never with Ammonites. The upper beaks have been described under the name of Rhyncholites, the lower ones as Conchorhynchus.

R. Astieriana, d'Orb. (xxxv, 74).

C. avirostris, Bronn (xxxv, 75).

C. Owenii, Bronn (xxxv, 76).

PELTARION, Deslongchamps. This was formerly believed to be the mandibular armature of tetrabranchiates, consisting of circular or transversely-oval calcareous plates, with rounded anterior and produced and truncated posterior margins. Through the researches of M. Crosse (*Jour. de Conch.*, 3 ser., xv, 57, 1875), there is no doubt that these Peltariæ are opercula of fossil species of *Nerítopsis;* they resemble the operculum of the recent *N. radula*.

Several species have been described from U. Lias to Coralline Rag. *P. bilobatum*, Desl. Upper Lias of Normandy.

Family AMMONITIDÆ.

Animal contained in the last division of a chambered shell; protected by one or two operculigerous plates (Aptychi); without ink-bag.

Shell external, of variable form, composed of two principal layers, the inner one of which is nacreous; sutural line of the septa more or less complicated or lobed; siphon simple, without organic layer.

Initial chamber ovoid, smooth, without exterior cicatrice, containing a siphonal cæcum free from the inner wall. Embryonic shell generally showing an umbilicus at each extremity of its axis; first chamber convex in front.

The above are the characters given to the order Ammonea by

Fischer, who places it between the Dibranchiata and Tetrabranchiata. The principal character which the Ammonitidæ possess in common with the former is the early development of the shell, the initial chamber being without cicatrice; but, on the other hand, the possession of an external shell is abundantly indicated by its exterior ornamentation, by its opercular plates and by other characters. I prefer to consider them tetrabranchiates—an opinion powerfully supported by Prof. Richard Owen, so lately as 1878.

The Ammonitidæ became essentially extinct towards the close of the secondary period, although a few forms are now referred to the tertiary. The geological position of the genera may be thus indicated:

Arcestes, Didymites, Lobites, Pinacoceras, Ptychites, Trachyceras, Tropites are exclusively Triassic.

Arietites, Harpoceras, Œkotraustes, Oppelia, Peltoceras, Stephanoceras, Simoceras, etc., are Jurassic.

Acanthoceras, Olcostephanus, Schlœnbachia, Stoliczkaia, etc., are Cretaceous.

Sageceras is Permian and Triassic. Ægoceras is Triassic and Liassic. Amaltheus, Lytoceras, Phylloceras, occur in Triassic, Jurassic and Cretaceous beds. Aspidoceras, Cosmoceras, Haploceras and Perisphinctes are found in the Jurassic and Cretaceous.

The aptychi or so-called opercula of Ammonites (ii. 33) are constantly found associated with (and generally within the aperture of) the shells of some of the groups. They are horny or shelly plates, and have been generally supposed to be opercula; if so, they were probably secreted by the disk or hood, which, formed by the coalescence of the two dorsal arms, closes the aperture of the recent Nautilus, and corresponds to the velamentous arms of the Argonaut. If the Ammonites were dibranchiates allied to Spirula—that is having internal shells—they could not have possessed opercula.

Prof. Waagen has adopted the theory first suggested by Keferstein and advocated by Zittel, that the aptychi were connected with the nidamental gland; and he has grouped the family according to the presence, absence or peculiarities of these bodies as follows:

A. Nidamental gland without solid integument or Aptychus: Phylloceras, Lytoceras, Arcestes, Pinnoceras, Trachyceras.

B. Nidamental gland with an Aptychus.

1. Gland simple, not divided.

   Aptychus horny: Arietes, Ægoceras, Amaltheus.

   Aptychus calcareous: *A. numida*, Coq. (shell unknown).

2. Gland double, aptychus calcareous.
   Aptychus furrowed externally: Harpoceras, Œko traustes, Oppelia, Haploceras, Scaphites?
   Aptychus thin, granulated externally: Stephanoceras, Perisphinctes, Peltoceras, Cosmoceras.
   Aptychus thick, smooth and punctate externally: Simoceras, Aspidoceras.

In the absence of positive knowledge as to the true relations of the Aptychi with the shells of Ammonites, and until much more extensive observations shall have been made, the groupings indicated above must be regarded as simply provisional.

One of the latest authorities on the subject (Prof. Owen, *Zool. Proc.*, 955, 1878), regards the aptychi as true opercula.

The following " genera " of Aptychi have been characterized:

TRIGONELLITES, Parkinson. Shelly, divided into two plates by a straight median suture; external surface smooth or sculptured, inner surface marked by growth-lines.

Associated with the round-backed Ammonites, and a single specimen with Goniatites. Nearly fifty varieties have been described.

Meyer considered them bivalve shells, and described them under the name of Aptychus; Deslongchamps, with the same impression, called them Munsteria; d'Orbigny thought them plates of cirripeds, and Deshayes believed them to be the gizzards of Ammonites; Coquand compared them with Teudopsis, and they certainly resemble in some degree that genus, as well as Beloteuthis, Belemnosepia, etc.

ANAPTYCHUS, Oppel. Horny and flexible, in a single piece. Associated with the Arietes group of Ammonites.

The classification of the Ammonitidæ, and particularly of the genera dismembered from the old genus Ammonites, is involved in much confusion, partly in consequence of the selection by several systematists of different generic characters as of primary importance throughout the group, partly owing to the instability of some of the most obvious characters. Surface ornamentation and even form are now known to change with age; and on this account the following scheme of classification of the genus Ammonites, elaborated by von Buch and d'Orbigny, is no longer available for the discrimination of the several thousand described species. As examples of the extent to which naturalists have been misled by these mutable characters, it may be mentioned that *A. splendens*, from the greensand of Cambridge, England, according to Mr. Seeley, includes fourteen other so-called species from the same bed.

A. Dorsal portion of whorls rounded, not keeled.

1. Fimbriati. Oolitic. *A. fimbriatus*, d'Orb. (xxxiii, 45, 46).
2. Planulati. Jura, Chalk. *A. annulatus*, Sowb. (xxxiv, 47, 48).
3. Ligati. Cretaceous. *A. ligatus*, d'Orb. (xxxiv, 49, 50).
4. Globosi. Alpine Trias.
5. Heterophylli. Jura, Alpine Trias. *A. heterophyllus*, d'Orb. (xxxiv, 51, 52).

B. Whorls dorsally flattened.

6. Capricorni. Jura. *A. capricornus*, Schloth. (xxxiv, 54, 55).
7. Armati. Jura. *A. longispinus*, Sowb. (xxxiv, 56, 58).
8. Coronarii. Jura, Chalk. *A. Blagdeni*, Sowb. (xxxiv, 57, 59).
9. Macrocephali. Jura. *A. Herveyi*, Sowb.
10. Compressi. Chalk. *A. Beaumontianus*, d'Orb. (xxxiv, 53, 60).

C. Dorsally channeled.

11. Dentati. Jura, Chalk. *A. mamillaris*, Schloth. (xxxv, 61, 62).

D. Dorsally keeled, keel entire.

12. Arietes. Lias. *A. bifrons*, Brug. (xxxv, 63). *A. bisulcatus*, Brug.
13. Falciformi. Jura. *A. serpentinus*, Schloth. (xxxv, 65, 66).
14. Cristati. Chalk. *A. cristatus*, Deluc. (xxxv, 67).

E. Dorsal keel crenated.

15. Amalthei. Jura. *A. cordatus*, Sowb. (xxxv, 68, 69).
16. Rothomagenses. Chalk. *A. rothomagensis*, Brong. (xxxv, 70).

F. Dorsally sharp-edged.

17. Disci. Chalk. *A. Metternichii*, Hauer (xxxv, 71).

Prof. Alpheus Hyatt, in his article on "Fossil Cephalopods," published in the *Bulletin of the Museum of Comparative Zoology*, i, 71, regards the Ammonoids, including all the cephalopods with serrated or foliated septa, the Clymeniæ, Goniatites, Ceratites, and Ammonites proper, "as a distinct order from the Nautiloids and Dibranchiate Cephalopods;" the typical group of this order being the so-called genus Ammonites. This enlarged view of the systematic position of the Ammonoids is by Prof. Hyatt attributed to Prof. Agassiz, but it is evident that von Buch had a glimmering of the same idea, because his groups (mainly those I have enumerated above), although permitted by him to remain under the generic name Ammonites, were designated as "families." Prof. Edward Suess, also, regarded the genus Ammonites as a family, the typical groups of which were of generic rank; and recently Dr. Paul Fischer adopts for them the order Ammonea.

Prof. Hyatt reverses the use of "dorsal" and "abdominal" in his descriptions of the shells; inasmuch as the animal of Nautilus and Ammonites is placed with its abdominal side to the periphery of the shell, he calls this outer side of the latter "abdominal," and the inner or sutural side "dorsal." I regard

this reversal of terms as objectionable, inasmuch as their exceptional use in the shells of tetrabranchiates must give rise to great confusion. He uses also the word "pilæ" for ribs, and "geniculæ" for the knees of the ribs.

A clear exposition of the reversed position of the animal of the tetrabranchiate, in relation to its shell, may be found in a paper by Prof. Owen, *Zool. Proc.*, 955, 1878.

Neumayr (1875) and Mojsisovics (1879, 1882) proposed systematic arrangements of the Ammonitidæ which agree in most of the main groups, but differ in details. The former dismisses Prof. Hyatt's classification (limited to Liassic species) with scant notice, his genera not being even enumerated, "because they do not agree with natural groups." I believe that both Hyatt and Neumayr would find it difficult to correlate their respective genera. The attempt has been made, however, by Dr. Paul Fischer in his excellent "Manuel de Conchyliologie," and if the result has not been satisfactory in all cases, it is at least far preferable to perplexing the student with three or more sets of generic names and diagnoses by presenting the several classifications in succession. I adopt Dr. Fischer's conscientious arrangement for the present, and hope that it will, as soon as may be, give place to a better grouping.

Siphonal neck of the septa directed backwards (Retrosiphonata). Goniatitæ.

Siphonal neck of the septa directed forwards (Prosiphonata).

No Aptychus, or corneous Anaptychus of one plate (Anaptychidea).

First saddle of the suture broad (Latisellata). Arcestæ, Tropitæ, Ceratitæ, Clydonitæ.

First saddle narrow (Angustisellata). Pinacoceræ, Amaltheæ, Ammonitæ, Lytoceræ, Phylloceræ.

Aptychus calcareous, double, or of two valves soldered together (Aptychidea). Harpoceræ, Stephanoceræ.

As Dr. Fischer regards the Ammonitidæ as an order, he has given the family termination to the above names: they will here be considered as group-names for assemblages of genera of the family Ammonitidæ. The position and appearance of the lobes and saddles of the septal sutures are represented and explained, ii, 22, 28; xxxii, 31; xxxiii, 41; xxxiv, 51, 52; xxxv, 72.

Goniatitæ.

Shell nautiloid; siphonal neck of the septa directed backwards. Siphon excentric. First whorls of the spire sometimes contiguous and covered as in Ammonites, sometimes not in contact, as in those of Spirula.

CLYMENIA, Münster, 1834.

Etym.—*Clymene*, a sea-nymph.

Syn.—Endosiphonites, Ansted, 1840; Planulites, Münst., 1832.

Distr.—37 sp. Devonian; Germany, England. *C. undulata*, Münst. (xxxi, 11). Fichtelgebirge.

GONIATITES, DeHaan, 1825.

Etym.—*Gonia*, angles. *Syn.*—Aganides, Montfort, 1810.

Distr.—About 320 sp. U. Silurian to Carboniferous; Europe, America, Australia. *G. Henslowi*, Sowb. (xxxii, 19). Carb. limestone; Isle of Man.

Shell spiral, discoidal; sutures of septa lobed; siphuncle dorsal, its tubes directed backwards; septa concave; margin of the aperture sinuous. Aptychus a single corneous plate. The genus reached its maximum development in the Devonian period. The shell of Goniatites being very variable in form and the species numerous, Beyrich, Sandberger and others have divided them into sections, which will probably, as in the case of Ammonites, form distinct genera hereafter. Sandberger uses the characters of the sutural line for his groups, as follows:

1. *Linguati.* Lobes and saddles linguiform, rounded.

2. *Lanceolati.* Lobes narrow, lanceolate; saddles rounded, claviform.

3. *Genufracti.* Second lateral saddle greatly developed, forming nearly a right-angle with the second lateral lobe; ventral lobe small.

4. *Serrati.* Lobes and saddles narrow, sharp, like the teeth of a saw.

5. *Crenati.* Ventral lobe very small; lateral saddle very large, rounded, separated from the rounded ventral saddle by a sharp lobe.

6. *Acutolaterales.* Ventral lobe simple, a lobe and sharp saddle on each side.

7. *Magnosellares.* Lateral saddle short and wide, lateral lobe rounded, ventral lobe thin.

8. *Nautilini.* Ventral lobe narrow; sutural lines simply arcuated on the sides.

In some of the Goniatites the first whorls are not in contact, recalling the shell of Spirula.

Arcestæ.

Shell smooth or with transverse folds, ribs or striæ; wrinkled layer consisting mostly of linear, interrupted striæ; impressions of the mantle attachment without or with a but slightly contracted opening always visible on the body-chamber. Anaptychus apparently horny in Arcestes.

ARCESTES, Suess, 1865.

Distr.—130 sp., Trias; several sp. Permian, and Carboniferous of India; 1 sp. Trias, N. Caledonia. *Arcestes tornatus*, Bronn (xxxviii, 20, 21).

Shell, as a rule, smooth, sculptureless, seldom with longitudinal striæ (Tornati); body-chamber long, taking up one to one and one-half whorls. Whorls strongly involute. Aperture usually contracted by the border being reflected inwards or by internal ridges. Lobes strongly incised (laciniated), so that the saddles merely consist of a slender stem with numerous approximated horizontal branches, which in turn are divided into smaller branchlets.

Many forms have internal nuclei with an open umbilicus, and a terminal whorl with a callous closed umbilicus.

ARCESTES (restricted). Last whorl of the spire more or less modified in form; umbilicus closed by a callous deposit.

SPHINGITES, Mojs., 1879. Surface of the last whorl sillonated; umbilicus open.

CLADISCITES, Mojs., 1879. Section of the whorls subquadrangular, their form not modified in the adults. The character of the suture recalls the Pinacoceræ; second lateral lobe deep, saddles slender, much divided.

JOANNITES, Mojs., 1879. Sutural lines like those of Cladiscites, but the other characters those of Arcestes. The sutural line is arcuated, lobes and saddles partly divided in pairs, much toothed.

DIDYMITES, Mojs., 1873. External form and length of body-chamber same as in Arcestes; shell with sharp lines of growth and plicate wrinkles throughout the whole length of the body-chamber to the aperture; on the inner convex surface of the shell there is a median furrow; the last whorl is constricted near the aperture.

The sutural lines of the septa are formed of few-toothed saddle pairs, which often alternate with single saddles. These saddle pairs, as is shown by projection of the spiral, correspond each to two saddles in the other genera of Ammonites.

Didymites contains but a few Triassic forms. *Didymites angustilobatus*, Hauer (xxxix, 32, 33).

CYCLOLOBUS, Waagen, 1879.

Distr.—*C. Oldhami*, Waagen (xxxvi, 93, 94). Palæozoic; India.

Shell spiral, smooth, with a small deep umbilicus; whorls numerous, somewhat compressed, with a broadly rounded external side, deeply embracing each other so as to envelop the preceding whorl, entirely covered on the sides with not very numerous contractions of the shell (varices), indicating very likely the remnants of old apertural margins. The form of these varices is somewhat falciform, with a strong bend towards the front in the middle of the sides of the whorl, and being bent

considerably backwards towards the external margin, entirely disappearing on the siphonal side of the shell. The increase in height of the whorls is very slow.

Closely related to Arcestes, of which it may be only a subgenus.

LOBITES, Mojs., 1873.

Syn.—Coroceras, Hyatt, 1877. Clydonites, Laube, non Hauer.

Distr.—Nine Triassic species are enumerated. *L. delphinocephalus*, Hauer (xxxvi, 92). *L. ellipticus*, Hauer (xl, 58, 59).

In external form and length of body-chamber agreeing with Arcestes and Didymites. Shell usually with tranverse folds, which are frequently crossed by fine longitudinal striæ. The body-whorl frequently assumes a form very different from the inner ones, and not unfrequently closes the umbilicus with a callus. Towards the aperture, however, and always in those forms with a closed umbilicus, there is a constriction which extends forwards in the form of small, projecting, lateral lobes. The sutural lines of the septa consist of entire-margined, high saddles, somewhat contracted at their bases, which vary in height in such a way that the second and fourth are perceptibly lower than would be expected from their position. A high siphonal process.

In many forms there appears, regularly at the end of the body-whorl and the one next to it, a portion constricted off the "hood;" in other forms the aperture is simple, and only prolonged anteriorly into lobe-like processes at the convex portions, and but little or not at all constricted.

In Lobites the derivation from the goniatitic ancestry is much more striking than in any other mesozoic genus, inasmuch as the form of the lobes is still completely goniatitic. The ammonitic stage is indicated in the structure of the lobes only by the high siphonal process dividing the external lobe.

Tropitæ.

Shell more or less richly ornamented, provided with radial ribs, which almost always support on the edge of the convex portion (frequently also on the sides) knobs and spinous processes. Wrinkled layer and impressions of the mantle attachments entirely absent.

TROPITES, Mojs., 1875.

Distr.—11 Triassic species. *Tropites Ramsaueri*, Quenst. (xl, 52, 55, 56).

Body-chamber long, embracing one and three-quarters to one and one-half whorls. The strong sculpture is interrupted on the convex portion of the shell; frequently a median keel is present on the same. At the aperture the convex portion is prolonged

into a broad, short lobe. The last whorl frequently differs in form and sculpture from the inner whorls. The lobes are distinguished by their broad saddle stalks, with divisions cut in obliquely, the oblique position of the tips of the lobes, great development of the principal lobes, and striking reduction of auxiliary ones.

HALORITES, Mojs., 1879. Body-chamber and spiral of the whorls as in Arcestes. Inner whorls with granulose ribs; saddles elevated, with many narrow lateral branches; lateral lobes reduced; last whorl with a different form and sculpture from the others; aperture a little contracted; a wrinkled layer present.

JUVAVITES, Mojs., 1879. Differs from Halorites by its last whorl resembling the preceding ones, and its less dentate lobes; the shell bears traces of periodical contractions.

DISTICHITES, Mojs., 1879. Convexity of the shell with a median groove, usually bordered by carinæ; inner whorls having the ornamentation of *T. Jockelyi*; last whorl with additional ribs intermediate to those which ornament the preceding whorls; body-chamber occupies more than a whorl; lobes as in Sagenites.

EUTOMOCERAS, Hyatt, 1877.

Distr.—*E. Laubei*, Meek (xxxvii, 6, 7). Trias; Nevada.

Characterized by its lenticular form, narrow umbilicus, apparently at all ages very sharp external keel, without furrows or lateral ridges, and small regular arched pilæ on middle-sized specimens, growing wider, more irregular, less distinct, and developing small lateral lobes on the adult, with both nodes and pilæ becoming obsolete on the larger part of the body-volution.

Ceratitæ.

CERATITES, de Haan., 1825.

Syn.—Haaniceras, Bayle, 1878.

Distr.—Permian, Trias. The Cretaceous forms referred to Ceratites perhaps belong to another group. *C. nodosus*, Brug. (xxxii, 23).

Shell discoidal, more or less sculptured; sutural line with simple, rounded saddles, and shallow denticulated lobes; antisiphonal lobe doubly toothed.

TIROLITES, Mojs., 1879. Lobes not toothed, or showing the commencement of teeth; second lateral lobe more or less salient; convexity of the whorls smooth, rounded, nearly flat. *C. Idrianus*, Hauer.

BALATONITES, Mojs., 1879. Periphery with a tuberculated carina. *C. Balatonicus*, Mojs.

HUNGARITES, Mojs., 1879. Shell narrow, with a much elevated median carina; lobes as in Ceratites. *C. Zalaensis*, Böckh.

ACROCHORDICERAS, Hyatt, 1877. This group is closely allied to

Lytoceras and Phylloceras, Suess, and Haploceras of Zittel, combining characteristics which are found in all of these, besides having peculiar characters of its own, and a different development. The extent of involution is comparable with that of Haploceras, but the whorl itself is about intermediate between the extreme roundness of Lytoceras and the more flattened sides of Phylloceras. Its peculiar characteristics consist in having large lateral tubercles and exterior pilæ, which are united as they near the tubercles. The smooth zone along the outer centre in the young is also probably of subgeneric value. *C. Hyatti*, Meek (xxxvii, 14). Trias; Nevada. Hyatt makes this a distinct genus of his family Physanoidæ, but Mojsisovics and Fischer class it as a group of Ceratites.

MEEKOCERAS, Hyatt, 1879. Distinguished from Ceratites by having but three distinct lateral cells and two lateral lobes, besides the finer auxiliary lobes and cells. The typical Ceratites have at least four distinct lateral cells and lobes besides the auxiliary ones, and the distinction is slight between the two series; in this genus, on the contrary, the auxiliary series, when present, is not divided from the third lateral cell by a distinct lobe, as in Ceratites, and the aspect of the third lateral cell is often like that of a Goniatites. The compressed whorls of all the species is of course a characteristic which is obvious when they are contrasted with typical Ceratites, as is also the absence, or merely transient appearance, of heavy nodes and ribs, except perhaps in the least involute species. *C. aplanatum*, White. Triassic; S. E. Idaho.

XENODISCUS, Waagen.

Distr.—*X. plicatus*, Waagen (xxix, 91, 92). Productus. Limestone (Carboniferous); India.

Shell flat discoidal, with compressed whorls, perfectly rounded on the siphonal side; umbilicus mostly large, and the whorls generally only slightly embracing each other; surface smooth, or with distant rounded folds which are thickest near the umbilical margin of the whorls, or with numerous slight plications which are straight on the sides of the whorls, and slightly turned towards the front near the siphonal margin; the sutures are very simple; the siphonal and two lateral lobes always well-developed, also a sutural lobe generally, but auxiliary lobes are generally absent. The lobes are furnished with a slight indentation at their termination, the saddles rounded, entire, without any indentation; the internal sutures show only one large antisiphonal lobe, which terminates in two long, sharp points; the body-chamber occupies not quite one whorl; aperture simple.

TRACHYCERAS, Laube, 1869.

Distr.—16 Triassic sp. *T. bicrenatus*, Hauer (xxxviii, 30, 31). *T. Whitneyi*, Gabb (xxxvi, 81, 89). Trias; Nevada, California.

Body-chamber short, one-half to two-thirds of a whorl long. The sculpture on the convex portion is interrupted; in the geologically younger forms a more or less deep median furrow is sunken in, at which the ribs terminate in a tubercle. Aperture with a short lobate process on the convex portion. Lobes agreeing with Tropites; much simpler in the geologically older forms.

ARPADITES, Mojs., 1879. Periphery with a deep groove, sometimes bordered by smooth or nodulous carinations; ribs numerous, dichotomous from an umbilical nodosity. The older forms have entire saddles; the more recent ones are toothed to the summit. *T. Arpadis*, Mojs.

HERACLITES, Mojs., 1879. Body-chamber only occupying half a whorl; ribs strong, nodulous on the sides; periphery of the last whorl flattened, with two thread-like spiral lines; lobes distinguished by several irregular notches, but deeply truncate. *T. Pöschli*, Hauer.

SAGENITES, Mojs., 1879. Body-chamber occupying half or three-quarters of the whorl; ribs usually not interrupted at the periphery, crossed by very close spiral lines; saddles high and wide, branched, foliaceous; lobes branched; auxiliary lobes very small. *T. Giebeli*, Hauer.

GYMNOTOCERAS, Hyatt, 1877.

Distr.—*G. rotelliforme*, Meek (xxxvi, 90, 91). Trias; Nevada.

The development of *Ammonites Blakei*, Gabb, and the characters of its periphery, separate it at once most decidedly from any species of Trachyceras. The development generally of a keel, or, in some varieties, of a raised periphery, over which the pilæ do not pass, shows that this is a different genus, characterized by a different mode of development. The septa are quite similar to those of Trachyceras, but it is very evident that in the Trachyceræ the septa cannot be looked to for generic differences. Great differences also occur in the amount of involution of the different species and in the development of their external characters.

Clydonitæ.

Body-chamber short; sutural line undulated; lobes and saddles simple, not dentate.

CLYDONITES, Hauer, 1860.

Etym.—*Kludon*, the surge.

Distr.—21 sp.; Upper Triassic; Europe, Himalayas. 2 sp.; Upper Cretaceous (described by d'Orb. as Ceratites. Difference from Ceratites is the lobes being simple, not crenulated). *C. costatus*, Hauer (xxxii, 27). *C. delphinocephalus*, Hauer (xxxii, 28).

Shell spiral, discoidal, whorls involute, ribbed; sutures simply lobed, the lobes pointed.

COROCERAS, Hyatt, 1877. The species all have numerous lobes and saddles, with smooth sutures, and a large exterior lobe which is very broad and prominent; they are plicately ribbed and very involute, the umbilicus nearly covered; mouth more or less hooded or constricted. *C. ellipticus*, Hauer (xxxvii, 8, 9).

CHORISTOCERAS, Hauer, 1875.

Distr.—9 sp. Trias. *C. Marshi*, Hauer.

Shell discoidal; body-chamber short; ribs interrupted by the convexity of the inner whorls, but continuous on the outer.

HELICTITES, Mojs., 1879. Whorls with strong, uninterrupted ribs; lobular line undulated, with small, almost microscopic denticulations. *C. geniculatus*, Hauer.

BADIOLITES, Mojs., 1879. Convexity of the whorls narrow and carinated; ribs falciform; lobes not truncate, undulated, except the antisiphonal lobe, which is long and pointed. *C. eryx*, Münster.

RHABDOCERAS, Hauer, 1860.

Distr.—*R. Suessii*, Hauer. Alpine Triassic; Germany (xxxii, 20, 21).

Shell straight, orthoceratoid, strongly sculptured; septa with rounded lobes.

Rod-like, elongated forms with oblique annular sculpture and simple curved lobes; still very imperfectly known.

COCHLOCERAS, Hauer, 1860.

Etym.—*Cochlos*, a snail-shell, *ceras*, a horn.

Distr.—3 sp. Alpine Triassic; Hallstadt, Austria. *C. Fischerii*, Hauer (xxxii, 25, 26).

Shell spirally elongated, scalariform, strongly sculptured; sutures of septa with several simple rounded lobes.

The whorls are spirally coiled to the left, with continuous ribs and simple curved lobes.

Pinacoceræ.

Body-chamber short, half or three-quarters of the last whorl; shell flattened, discoidal; sutural line very complex, with three groups of lobes (adventive, principal and auxiliary).

PINACOCERAS, Mojs., 1873.

Syn.—Megaphyllites and Carnites, Mojs., 1878.

Distr.—12 sp. from the Triassic. *P. Metternichii*, Hauer, (xxxv, 71).

Shell narrow, aperture high, smooth, seldom with knob-like enlargements on the surface. Body-chamber one-half to two-thirds of a whorl long; aperture with short lobular process of the convex portion. Attachment ring commencing a short distance from the aperture and extending to the posterior end of

the body-chamber. Impressions of the mantle attachment punctate or striate. Wrinkled layer consisting of broken-up striæ. The sutural line of the septa is distinguished by the presence of external adventitious lobes. Three groups of lobes may accordingly be distinguished: 1. The adventitious lobes. 2. The three principal lobes. 3. The auxiliary lobes. The adventitious and auxiliary lobes always present a similar structure, whilst the principal lobes frequently present a peculiar form.

SAGECERAS, Mojs., 1873.

Distr.—7 sp. Permian and Triassic. *Sageceras Haidingeri*, Hauer (xl, 48, 49).

Close to Pinacoceras in the form of the shell and length of the body-chamber, and differs from it in the structure of the wrinkled layer, the form of the lobes and the direction of the lines of growth in the concave portion. The wrinkled layer is coarsely granular, as in Nautilus, and does not consist of long striæ and threads, as in the Arcestæ. The saddles are slender, narrow, tongue-like, entire, the lobes symmetrically divided, simply or doubly, by simple conical teeth. Three groups of lobes, as in Pinacoceras. The lines of growth do not trend backwards, as in Pinacoceras, but forwards.

Sageceras is already fully developed in the Permian formations, though in these older forms the siphonal process characteristic of the Ammonite stage is wanting.

NOVITES, Mojs., 1878. Wrinkled layer striated; an adventive saddle not reaching the height of the first principal saddle; saddles narrow, elevated, rounded at their superior extremity; lobes but little truncate; first principal lobe divided. *S. Caprilensis*, Mojs.

MEDLICOTTIA, Waagen, 1880. Siphonal side (periphery) either excavated and rounded on both sides by high and sharp crests, or simply flattened, and defined on both sides by angular margins. In both cases the high and narrow saddles developed on each side of the siphonal lobe are situated exactly below the crests or the angulated margins; these saddles are strongly serrated from both sides, and the denticulations of the opposite sides of the saddle correspond exactly with each other. *M. Wynnei*, Waagen (xxxix, 43, 44). Productus Limestone (Carboniferous); India.

OTOCERAS, Griesbach, 1881.

Distr.—*O. Woodwardi*, Griesb. (xxxix, 40–42). L. Triassic; Himalayas.

Shell involute, with very deep umbilicus, and rapidly increasing outer whorls; the part nearest the umbilicus bulged out into an ear-like shape, giving the section of the shell a more or less rhomboidal aspect. It is very probable that in adult individuals the last whorl covered and enclosed the entire preceding shell.

Amaltheæ.

Shell generally flattened and carinated, the last whorl of the spire covering a large part of the preceding; sutural line with several auxiliary lobes. Aptychus simple, corneous, only known in the Jurassic forms.

AMALTHEUS, Montfort, 1808.

Distr.—68 species. Triassic, Jurassic and Cretaceous. *A. margaritatus*, d'Orb. (xxxviii, 26, 27).

Periphery sharpened or carinate; ribs when present, absent at this part or broken up into tubercles or folds; the geologically older forms with spiral striæ on the external layer of the shell, which corresponds to the wrinkled layer of the Arcestæ. Body-chamber short, one-half to two-thirds of a whorl long; margin of aperture simply emarginate, with long, external processes, ending in spoon-shaped extremities, sometimes bent outwards or inwards. Lobes usually strongly incised, siphonal lobe shorter than the first lateral, lobular bodies broadly wedge-shape. Umbilicus open, with the sides of the whorls exposed or only partially covered.

PLEUROCERAS, Hyatt, 1868. (Prionotropis, Meek, 1876.) Periphery flat, with keel and channels well defined; keel crenulated; channels vary from obsolete to deep and well-defined, pilæ swelling below, tuberculated; genicular bend prominent. Tubercles lateral, arranged along the line of envelopment. Umbilicus open. Ventral lobe narrow and but slightly deeper than the lateral lobes; the latter unequally divided. Inferior lateral lobe small, shallow, equally divided. Superior lateral cell only partly exposed on the side, and together with the inferior lateral, unequally divided. Scarcely distinct from Amaltheus. Middle Lias, Cretaceous. *A. spinatus*, Brug. (xxxviii, 24, 25). *A.* (*Prionotropis*) *Woolgari*, Mantell (xxxvii, 10, 11).

OXYNOTICERAS, Hyatt, 1874. Periphery carinated in the young shell, rounded in the adult. *A. Guibalianus*, d'Orb. (xl, 50, 51). Lower Lias.

PTYCHITES, Mojs., 1875. Shell covered with undulated radiating plications; exterior lobe shallow; exterior saddle but little elevated; first lateral saddle very high; saddles dentate or slightly branched. This group, which corresponds to the Plicosi of Beyrich and the Rugiferi of Oppel, may be considered an ancestral form of Amaltheus. Six Triassic species. *A. Studeri*, Hauer.

SCHLOENBACHIA, Neumayr, 1875.

Dedicated to the geologist, Schloenbach.

Syn.—Mortoniceras, Meek, 1876.

Distr.—46 species. Cretaceous; Europe and United States.

S. cristata, Deluc. (xxxv, 67). *S.* (*Mortoniceras*) *vespertinus*, Morton = *S. Texanus*, Roemer (xxxvi, 86).

This genus embraces the very natural group of Cristati; to these may be added *Schl. Germari*, Reuss., whose affinity to these is indicated, besides other striking characters, by a toothed keel. Shell strongly keeled, usually with strong ribs curved forwards on the flanks; body-chamber two-thirds of a whorl long, drawn out at the sickle-shaped aperture into a long, beak-like process, which is either prolonged in conformity with the curvature of the spiral or bent outwards. Siphon very stout, usually lying in the keel, which is often cut off from the lumen of the shell by a calcareous septum. Lobes not much branched, with bodies which are narrower than the saddles; only one distinct auxiliary lobe; which is wanting in some forms. Siphonal lobe usually as long or longer than the first lateral. In some species a great reduction in the number of branches of the lobes takes place, so that they approach a Ceratitic form. (*Schl. senequeri* and *halophylla*.)

PLACENTICERAS, Meek, 1870.

Distr.—Cretaceous; United States, India. *A. placenta*, DeKay (xxxvi, 82).

Shell with the very narrow periphery truncated, and often provided with a row of compressed alternating nodes along each margin; volutions about three-fourths embraced by the next succeeding outer one; septa with the lateral sinuses provided with more or less branched and digitate terminal divisions; umbilicus small or moderate.

SPHENODISCUS, Meek, 1872. Shell with periphery cuneate; umbilicus very small; volutions each almost entirely embraced by the succeeding one; septa with the first five or six lateral sinuses provided with only a few short, nearly simple, obtuse divisions; while the others are simple, and usually broadly reniform at the ends. Cretaceous; United States, Europe. *Amm. lobatus*, Tuomey.

Meek thinks that some of the species of Pinacoceras, Mojsisovics, will fall into this group; and that that genus is too comprehensive. Sphenodiscus equals the Clypeiformi group of Ammonites.

NEOLOBITES, Fischer, 1882. Shell flattened, sharply carinated; lobes and saddles simple, not truncate, resembling those of the triassic Lobites. *P. Vibrayeanus*, d'Orb. Cenomanian.

BUCHICERAS, Hyatt, 1875.

Dedicated to Dr. L. von Buch, a German naturalist.

Distr.—Cretaceous. *B. Syriacum*, Buch.

Shell ornamented with strong ribs, dichotomous, from tubercles near the umbilicus; ribs interrupted at the periphery; lobes

shallow, but little truncate and resembling those of Ceratites; saddles not high, rounded, simple or slightly divided; siphonal saddle small; some auxiliary lobes.

Founded on the cretaceous species of Ceratites, which differ from the triassic forms in the characteristics of the sutural outlines: they are not Ceratites at all, but, strictly speaking, Ammonites.

Ammonitæ.

Spire-whorls narrow, exposed, with radiating ribs; aperture simple; sutural line normal, without accessory lobes. Aptychus a single corneous plate.

AMMONITES (Breyn., 1732), Lamarck, 1801.

Etym.—*Ammon*, a surname of Jupiter.

Syn.—Arietites, Waagen, 1869. Coroniceras, Hyatt, 1867. Asteroceras, Hyatt, 1867. Arnioceras, Hyatt, 1867. Discoceras, Hyatt, 1867.

Distr.—40 sp. Jurassic, Liassic. *A.* (*Asteroceras*) *obtusus*, Sowb. (xxxvi, 79, 80; xxxiii, 44). *A.* (*Arnioceras*) *Kridion*, Orb. (xxxvii, 100, 1). *A.* (*Coroniceras*) *bisulcatus*, Brong. (xxxv, 64). *A.* (*Discoceras*) *Ophidioides*, d'Orb. (xxxvii, 98, 99).

Shell discoidal, flattened, whorls exposed, ornamented with inflected ribs becoming nodulous at the periphery; periphery carinated, with a groove on each side of the keel, and another carina outside the groove; section of the last whorl subquadrangular; body-chamber very long, sometimes exceeding a whorl; aperture simple, with a sharp, not inflected peripheral prolongation; sutural line with a ventral lobe longer than the lateral superior lobe, the latter higher than all the others; inferior lateral lobe wide; antisiphonal lobe two-pointed.

The above diagnosis is of Ammonites as restricted by modern naturalists: the ancient genus, before its dismemberment, contained two or three thousand species, and was divided into sections (p. 63), many of which correspond to modern genera.

CALOCERAS, Hyatt, 1870. (Ophioceras, Hyatt, 1867. Echioceras, Bayle, 1878.) Ribs not arcuated; carina of the periphery sometimes not very distinct, without grooves. *A. torus*, d'Orb. (xxxvi, 77, 78).

EUDISCOCERAS, Hyatt, 1877. This type is distinguished by its discoid form, open umbilicus, and a keel, bordered by furrows and ridges, the latter being interrupted or tubercular; the young with comparatively large pilæ, growing smaller and more flexuous in the adult, and finally fading away in the larger half of the body-volution. *E. Gabbi*, Meek (xxxvii, 4, 5). Trias; Nevada.

AGASSIZICERAS, Hyatt, 1874. Ribs slightly arcuated; carina not bordered by grooves. *A. Scipionianus*, d'Orb. (xxxviii, 22, 23).

LILLIA, Bayle, 1878. In the young shell the ribs are simple or bifurcated, commencing with tubercles at the umbilical region; later the ribs are simple and the shell resembles Agassiziceras. Perhaps this group would be better placed near Harpoceras: the limit between the latter genus and Ammonites is very difficult to trace, without the aid of the aptychus.

ÆGOCERAS, Waagen, 1869.

Syn.—Mycroceras, Hyatt, 1867. Androgynoceras, Hyatt, 1867. Liparoceras, Hyatt, 1867. Deroceras, Hyatt, 1867. Peronoceras, Hyatt, 1867. Platypleuroceras, Hyatt, 1867. Cycloceras, Hyatt, 1867. Psiloceras, Hyatt, 1867.

Distr.—4 Cretaceous, 54 Liassic species. *Ægoceras* (*Microceras*) *biferum*, Quenst. (xxxvii, 96, 97). *Æ.* (*Androgynoceras*) *hybridum*, Hyatt (xxxvi, 83, 84). *Æ.* (*Lyparoceras*) *Henleyi*, Sowb. (xxxvi, 85). *Æ.* (*Deroceras*) *Ziphius*, Ziet. (xxxvii, 95). *Æ.* (*Peronoceras*) *muticum*, d'Orb. (xxxviii, 13, 14). *Æ.* (*Platypleuroceras*) *latecostatum*, Sowb. (xxxviii, 19). *Æ.* (*Cycloceras*) *Valdani*, d'Orb. (xxxix, 34, 35). *Æ.* (*Psiloceras*) *psilonotum*, Quenst. (xxxvii, 2, 3).

Shell mostly compressed, composed of many whorls, embracing but little, sometimes provided with nodose or externally bifurcate ribs; never with true sickle-like ribs; not carinate; body-chamber usually a whorl long, in the geologically younger forms somewhat shorter. Aperture simple without lateral appendages, with very weak external lobes and a constriction; a single corneous aptychus. Lobular line strongly notched, upper lateral longer than the siphonal, lower lateral not always present; usually with a depending siphonal lobe. Lobular bodies narrow, not wedge-shaped; antisiphonal two-pointed.

The true Ægoceras died out in the middle Lias.

Ægoceras corresponds to the group Ammonites Capricorni of Buch.

SCHLOTHEIMIA, Bayle, 1878. Ribs meeting exteriorly, where they form an angle directed towards the aperture. *Æ. angulatum*, Schloth.

Lytoceræ.

Body-chamber short, two-thirds of the last whorl; aperture simple. No aptychus.

LYTOCERAS, Suess, 1865.

Syn.—Thysanoceras, Hyatt, 1867.

Distr.—62 species from the Trias, Jura and Cretaceous. *L. Henleyi*, Sowb. (xxxvi, 85). *L. Moreleti*, Hauer (xxxviii, 28, 29). *L.* (*Thysanoceras*) *fimbriatus*, Sowb. (xxxiii, 45, 46).

Shell flattened, discoidal, whorls but little involute or simply in contact; body-chamber two-thirds of a whorl, margin of aper-

ture at the columellar side produced into a lobe, processes wanting at the siphonal side and on the flanks; lines of growth and sculpture parallel to the margin of the aperture, at the suture bent forwards; sculpture feeble, mostly consisting of radial lines or interruptions; sutural line with few lobes, lateral lobes and saddles symmetrically divided, columellar lobe two-pointed. No aptychus.

The forms of the Trias diverge herefrom in such a way, that in them the lines of growth and sculpture, as in Phylloceras, are directed forward at the siphonal side, and that the structure of the saddles is monophyllic.

Lytoceras corresponds to the Fimbriati group of Ammonites.

MONOPHYLLITES, Mojs., 1879. Differs in the saddles being monophyllic. *L. sphærophyllum*, Hauer.

OPHICERAS, Griesbach, 1881. Compressed; section of whorls oval and widening near the umbilicus, the latter large and shallow; thick, covered with fine wrinkles or growth-lines of sigmoid shape, becoming fine ribs in the body-chamber: at irregular intervals the shell swells into rounded bumps, largest near the umbilical margin; the periphery is rounded, and the wrinkles or folds run across it and join with those of the other side. Both in general shape and number and arrangement of the lobe-lines, this subgenus closely resembles the Lytoceratite groups Monophyllites and Phylloceras, and it may be said to be an earlier stage of those forms. *C. Tibeticum*, Griesb. (xl, 45). L. Trias; Himalayas.

PHYLLOCERAS, Suess, 1865.

Syn.—Rhacoceras (Agassiz), Hyatt, 1867.

Distr.—77 sp. Triassic, Jurassic, Cretaceous. *P. ocultum*, Mojs. (xxxix, 38, 39). *P.* (*Rhacoceras*) *heterophyllum*, Sowb. (xxxiv, 51, 52).

Shell discoidal, involute, with feeble sculpture, sometimes with constrictions or varices, lines of growth directed forwards; body-chamber short, margin of aperture simple with somewhat produced lobes on the external side; no aptychus; lobes numerous, diminishing regularly in size, laterals without subdivision into principal paired branches; leaves or lobes of the saddles very much rounded; antisiphonal lobe two-pointed.

This genus is remarkable for its persistence in the secondary strata. The triassic forms are characterized by their less numerous lobes, and more open umbilicus. Prof. Meek includes a few American cretaceous species in the genus.

Harpoceratæ.

Aperture with more or less developed lateral ear-like prolongations; sutural line with accessory lobes; surface ornamented

with straight or curved radiating ribs. Aptychus calcareous, grooved, formed of two plates.

HARPOCERAS, Waagen, 1869.

Syn.—Grammoceras, Hyatt, 1867. Leioceras, Hyatt, 1867. Lioceras, Bayle, 1878. Hammatoceras, Hyatt, 1867. Ludwigia, Bayle, 1878. Phymatoceras, Hyatt, 1867. Pelecoceras, Hyatt, 1867. Tropidoceras, Hyatt, 1867. Waagenia, Bayle, 1878. Sonninia, Bayle, 1878.

Distr.—96 sp. Jurassic. *Harpoceras* (*Tropidoceras*) *Actæon*, d'Orb. (xxxviii, 17, 18). *H.* (*Grammoceras*) *serpentinum*, Schl. (xxxv, 65, 66). *H.* (*Leioceras*) *complanatum*, Brug. (xxxix, 36, 37). *H.* (*Hammatoceras*) *insignis*, Schloth. (xxxviii, 15, 16).

External form of the shell variable, outer side always carinate or angular; sculpture consisting of more or less distinct sickle-like ribs. Margin of aperture sickle-shaped, or with ears, with pointed external lobes; body-chamber embracing one-half to two-thirds of a whorl, carinate to the margin of the aperture. Aptychus divided, thin, calcareous, with a thick, shelly layer, more or less folded.

Lobes mostly not deeply notched, always two lateral lobes and almost always auxiliaries. Siphonal lobes ending in two diverging branches, usually shorter than the first lateral; laterals not divided into symmetrical halves.

This genus corresponds to Buch's group Ammonites Falciferi.

HILDOCERAS, Hyatt, 1867. Carina bordered on either side by a groove. *H. bifrons*, Brug. (xxxv, 63).

OPPELIA, Waagen, 1869.

Dedicated to the palæontologist, Oppel.

Syn.—Neumayria, Bayle, 1878. Œcotraustes, Waagen, 1869.

Distr.—71 sp. *O. subradiata*, Sowb. (xl, 57). *O.* (*Neumayria*) *fulgens*, Trautsch. (xxxix, 88, 89).

Shell with umbilicus usually narrow, external side either rounded only on the body-chamber or on all the whorls. Sculpture sickle-shaped, body-chamber frequently geniculate, never carinate or angular, embracing one-half to two-thirds of a whorl; margin of aperture sickle-shaped or with ears, always with rounded external lobes. Siphon stout with calcareous sheath. Lobes moderately branched, siphonal mostly shorter than the first lateral; lobular bodies slender with almost parallel edges; lateral lobes divided into two principal symmetrical branches. Aptychus divided, calcareous, thick, folded (*Apt. lamellosus*); muscles of attachment near the margin in the lower half of the shell.

Oppelia branches off in the lower Oolite with *Opp. subradiata* from Harpoceras; the last representatives, as far as we know,

appear in the upper Jura of Stramberg, where a considerable number of different forms are found.

The genus Œcotraustes was created for species of the group of *O. genicularis*, Waagen; Neumayria for such species as *O. trachynotus* and *O. Hauffiana*, of Oppel.

HAPLOCERAS, Zittell, 1870.

Syn.—Lissoceras and Puzosia, Bayle, 1878.

Distr.—76 sp. Jurassic, Cretaceous. *H. ligatum*, d'Orb. (xxxiv, 49, 50).

Established for a group allied to Oppelia from the middle and upper Jurassic, which is characterized by very feeble or no sculpture; also some cretaceous forms, as *Hapl. Grusanum*, are placed here; and with them forms very pronounced wedge- or chisel-shaped in section, as *Hapl. belus*; finally, species with quite sharp external sides, as *Hapl. nisus*, Orb.

In other jurassic species of Haploceras, there is gradually developed a transverse sculpture, which is confined to the external side of the body-chamber (*Hapl. jungens*, Neum., *carachtheis*, Zeuschner).

In certain upper jurassic forms, which are allied to *Hapl. carachtheis*, the sculpture gradually passes from the external side over to the flanks in feebly undulating ribs, as is shown in *Hapl. cristiferum*, Zitt.; better developed in *Hapl. wöhleri*, Opp.; and this feature is repeated in *Hapl. difficile*, Orb., *Cleon*, Orb., *bicurvatum*, Leym.

Finally, species of Haploceras appear which are distributed in the cretaceous, with constrictions reaching forwards (*Hapl. Beudanti*, *Parraudieri*), a peculiarity which does not occur in any Jurassic form; the inner whorls here serve as sure guides, aside from the agreement of the lobular markings, since they represent a typical Haploceras with entirely smooth whorls. With these furrows a sickle-shaped undulating radial sculpture is gradually combined, and a group of forms results, of which the principal type is *Hapl. planulatum*, Sow.

In spite of this great manifoldness, it is very easy to distinguish the representatives of Haploceras from strata which are lower than the turonian and downwards, by their whole habitus and lobes, yet nothing is more difficult to express in words.

This genus corresponds with Ammonites Ligati of d'Orb. Bayle changed the name to Lissoceras, because Haploceras was preoccupied by d'Orbigny; the latter's species is, however, a synonym of Cyrtoceras.

Stephanoceratæ.

Form very variable. Aptychus calcareous, granular, formed of two plates, which are sometimes joined at the median line. The Stephanoceratæ may be subdivided into *normal*, with regular

discoidal, spiral shell, and *evolute*, with discoidal, helicoid or straight shell, the whorls unwound partly or entirely. This evolution is partly generic, but in some instances is known to be accidental: thus specimens of *Acanthoceras angulicostatum*, d'Orb. have the whorls slightly embracing, or merely in contact (Lytoceras), or completely detached (Crioceras).

a. Normal.

STEPHANOCERAS, Waagen, 1869.

Syn.—Dactylioceras, Hyatt, 1867. · Globites, de Haan, 1825. Orbulites, Lam., 1801. Sphæroceras, Bayle, 1878.

Distr.—41 Jurassic sp. *S.* (*Dactylioceras*) *annulatum*, Sowb. (xxxiv, 47, 48). *S. Blagdeni*, Sowb. (xxxiv, 57, 59).

General form of the shell very variable, external side rounded without keel, angle or furrow. Sculpture never sickle-shaped, decorated with straight, bifurcating ribs, abundantly provided with nodes or swellings. Margin of aperture simple or with ears mostly formed of a broad, smooth zone; aperture frequently constricted. Body-chamber one to one and one-quarter whorls long. Lobes usually deeply divided, siphonal and upper lateral lobe usually of the same length; a stout auxiliary sutural lobe; lobular bodies narrow. Aptychus divided, calcareous, very thin, covered with granules on the external surface.

Stephanoceras diverges from Ægoceras with *Steph. pettos* in the middle Lias; according to the subdivision into groups, it embraces the Liassic Planulata, Coronata and Bullata after the exclusion of some heterogeneous elements; the last representatives come from the Oxfordian (*Steph. Collini*, Opp., *glomus*, Opp.).

CADOCERAS, Fischer, 1882. Shell much swollen; umbilicus narrow, carinated; last whorl entirely smooth, preceding whorls with ribs forming an angle directed forwards in the ventral region. *S. modiolare*, Luid.

PROTOPHYTES, Ebray, 1860. Last whorl geniculated, embracing; umbilicus transverse, linear; ribs interrupted at the periphery; aperture with a peripheral appendage, triangular, wide and thick. *S. Oxfordianum*, Ebray.

ŒCOPTYCHIUS, Neumayr, 1878. Last whorl geniculated, embracing; lateral ear-like projections short and narrow; a cowl-like ventral appendage. *Œ. refractus*, de Haan.

MORPHOCERAS, Douvillé, 1880. Whorls rounded with radiating ribs uniting in groups of one to three near the umbilicus, which is scalariform in the juvenile, and much widened in the adult; aperture geniculated, almost completely closed by the expansion of the lateral ears, which unite at the median line on one side and on the other touch the preceding whorl; thus there are, so to say, five apertures, the peripheral, two small ones, placed each

side of the peripheral, two half-round ones limited partly by the preceding whorl. *S. pseudo-anceps*, Ebray.

COELOCERAS, Hyatt, 1867.

Distr.—*C. centaurus*, d'Orb. (xxxvi, 87, 88). Middle and Upper Lias.

Pilæ on the periphery bifurcated; lateral pilæ single or bifurcated with one external row of tubercles, occurring regularly on each, or at intervals on widely separated pilæ. The young are very much flatter than the adults, and the sides consequently very narrow. They are smooth for the first one or two whorls, subsequently becoming tuberculated. The tubercles almost immediately spread, forming the pilæ; they may enlarge and remain distinct, or become absorbed and disappear upon alternate pilæ. The abdomen remains perfectly smooth for some time after the lateral pilæ are developed, not acquiring the abdominal pilæ until the third whorl is reached. Septa close together and very intricate in the adult. Abdominal lobe broader and deeper than the superior lateral. The inferior lateral is nearly the same in size, and both are unequally divided into three shallow, minor lobes. Superior lateral cell lobiform and together with the inferior lateral, unequally divided by two minor lobes.

COSMOCERAS, Waagen, 1869.

Syn.—Parkinsonia, Bayle, 1878.

Distr.—42 sp. Jurassic. *C. Calloviense*, d'Orb. (xl, 46, 47).

Siphonal side (periphery) mostly with a smooth furrow; sculpture consisting mostly of dividing ribs, directed forwards at the periphery, frequently ornamented with nodes or swellings; margin of aperture in the young state frequently with ears, which are lost by age; body-chamber one-half whorl long. Lobes moderately divided; siphonal lobe distinctly shorter than the first lateral; second lateral repeating the form of the first; one or more auxiliaries. Aptychus apparently as in Stephanoceras.

PERISPHINCTES, Waagen, 1860.

Syn.—Ellipsolithes, Montf., 1808. Planulites, Montf., 1808. Pictonia, Bayle, 1878.

Distr.—161 sp. Jurassic, Cretaceous. *Perisphinctes arbustigerus*, d'Orb. (xli, 60, 61).

Shell mostly with wide umbilicus, with rounded external side, sculpture consisting mostly of straight, undivided, not nodose ribs; margin of aperture simple or with ears, with a constriction; also isolated constrictions on the inner whorls. Length of body-chamber two-thirds to one whorl, mostly scarcely embracing one circumference or turn. Lobular line similar to Stephano-

ceras, usually somewhat more deeply notched, with a dependent sutural lobe. Aptychus divided, calcareous, very thin, externally granular.

This group corresponds to the Planulati of Buch.

SIMOCERAS, Zittel.

Distr.—26 sp. Jurassic. *S. Jooraensis*, Waagen (xli, 66, 67).

Shell very flat, discoidal, umbilicus wide, with numerous whorls, which increase in thickness very slowly (except in the geologically oldest forms); external side rounded or grooved; sculpture seldom absent, consisting mostly of straight, simple or forked ribs, which are interrupted during most of the lifetime of the animal; interrupted at any rate in the young state on the external side, and which are often ornamented with tubercles or strongly swollen on the last whorl; isolated constrictions directed forwards on all the whorls. Body-chamber long, at least three-quarters of a whorl, usually attaining a greater length. Lobular line not very complicated. Siphonal lobe largest, external saddle much developed and broad, laterals one-pointed, very small in the geologically younger forms. Aptychus (?).

REINECKEIA, Bayle, 1878. Shell close to Perisphinctes, but with more marked constrictions, and a peripheral groove. *S. anceps*, Reinecke.

PELTOCERAS, Waagen, 1871.

Distr.—13 sp. Jurassic; Europe, India. *P. Arduennense*, d'Orb. (xli, 64, 65).

Shell when young having the ornamentation of Perisphinctes; when adult, with straight tuberculated ribs; aperture with persistent lateral projections.

ASPIDOCERAS, Zittel, 1866.

Syn.—Waagenia, Neumayr, 1878.

Distr.—48 sp. Jurassic, Cretaceous. *A. longispinum*, Sowb. (xxxiv, 56, 58).

External form very variable, sometimes flat with wide umbilicus, sometimes inflated with a narrow umbilicus; external side rounded or with a broad external furrow, never with a carina or angle. Sculpture consisting of one or two rows of tubercles or wanting. Ribs, as a rule, present only in the young state. Margin of aperture simple (*Asp. aporum* with ears?), body-chamber short, embracing two-thirds of a whorl. Lobular line tolerably simple; siphonal, two laterals, also often (in the geologically younger species) an auxiliary lobe. Lobes not much cut (with the exception of *Asp. Altenense* and *circumspinosum*); bodies of the lobes and saddles broad. Cellulose aptychi.

Aspidoceras reaches the highest point of its development in the Kimmeridgian, and dies out in the Neocomian.

ACANTHOCERAS, Neumayr, 1875.

Distr.—36 sp. *A. Rotomagense*, Brong. (xxxv, 70).

Shell with a moderately wide umbilicus and not very elevated whorls. Margin of aperture and length of body-chamber unknown. The sculpture consists of quite straight ribs, which become constantly stronger from the suture outwards to the external side, which are frequently ornamented with a greater or less number of tubercles or nodes, and are most curved in young individuals. The development of the external side is very variable, the middle line sometimes with uninterrupted ribs, sometimes with a furrow, sometimes with a line of tubercles, the elements of which attempt to unite into a keel. Lobular line much reduced; besides the two laterals on the flanks there is at most one auxiliary, or a row of two to three extremely small deep-lying auxiliaries; bodies of the lobes and saddles plump and broad, the last broader than the first, no branching, but only a dentation of the lobes. Siphonal and first lateral usually not very different in size, the first often larger than the last; second lateral much smaller than the first, both one-pointed.

STOLICZKAIA, Neumayr, 1875.

Dedicated to Dr. Stoliczka, of the Geological Survey of India.

Distr.—8 sp. Cretaceous; India. *S. dispar*, Stol. (xli, 62, 63).

Forms allied to *Hoplites dutempleanus*, with expanded body-chamber, embracing three-fourths (?) of a whorl. Margins of aperture curved, produced at the middle of the flanks, slightly emarginate at the external side. Inner whorls with radial ribs which are not interrupted on the external side, and usually here attain their maximum strength; body-chamber smooth or with thickened ribs; external side without keel or furrow. Lobular line branched, consisting of a siphonal, two lateral, and one or more less dependent sutural lobes.

HOPLITES, Neum., 1875.

Syn.—Sonneratia, Bayle, 1878.

Distr.—50 sp. Cretaceous. *H. Archiacianus*, d'Orb. (xli, 68, 69).

Derived from the group of forms represented by *Perisphinctes involutus*, with moderately narrow umbilicus and high whorls; thickness very variable. Margin of aperture and length of body-chamber unknown. Sculpture consisting of divided and curved ribs, which originate near the umbilicus or in the middle of the flanks in small, thickened, primary ribs or a tubercle; ribs interrupted on the periphery, often separated by a deep furrow, or at least feebler at this point; ribs enlarged at both extremities, weaker at the middle of the flanks. Lobular line complicated, with branches and numerous auxiliaries; lobular bodies not very plump; saddles as wide or (mostly) wider than

the lobes. First lateral always longer than the siphonal lobe; second lateral strikingly short; auxiliary horizontal or very slightly depending.

OLCOSTEPHANUS, Neumayr, 1875.

Distr.—33 sp. Jurassic to Cretaceous; Europe, India. *O. Bhawani*, Stol. (xl, 53, 54).

Body-chamber only about one-third of the last whorl; surface ornamented by ribs which are interrupted at the rounded periphery; aperture simple or eared, contracted; most of the species are distantly constricted; sutural line complicated by the presence of three auxiliary lobes.

b. Evolute.

SCAPHITES, Parkinson, 1811.

Etym.—*Scaphe*, a boat.

Distr.—34 sp. Cretaceous; Europe, America. *S. æqualis*, Sowb. (xxxii, 35). Sussex, England.

Shell at first closely spiral, involute, at length detached and recurved; sutures many-lobed, lobes foliated.

The Scaphites (with the exclusion of *Sc. Yvanii*) form a very good natural group, very distinctly characterized by the involute spiral of the chambered portion of the tube, to which but one very short evolute hook is attached, by their aptychus, which by its form, its want of strong longitudinal sculpture, and the surface covered with granules, is allied to the aptychi of Perisphinctes, and by the appearance of auxiliary lobes, which are wanting in all other evolute forms. The form of the aptychus decidedly indicates that they are serially to be connected with the Perisphinctes-stem, and the form of the inner whorls of the geologically old species, which agree entirely in form with *Olc. Guastaldinus*, indicates strongly their connection with *Olcostephanus*, which is also confirmed by the form of the aperture.

DISCOSCAPHITES, Meek, 1876. For forms, the ornamentation of which recalls that of Acanthoceras. *S. Cheyennensis*, Owen; *S. Conradi*, Morton.

HAMITES, Parkinson, 1811.

Etym.—*Hamus*, a hook. *Syn.*—Ammonoceras, Lam., 1822.

Distr.—150 sp. Cretaceous. *H. attenuatus*, Sowb. (xxxiii, 40). *H. cylindraceus*, Defr. (xxxiii, 41).

Shell with the tube unrolled, and variable in ornamentation; sutural line rather simple; a siphonal lobe, two lateral lobes divided into pairs — sometimes symmetrical, sometimes asymmetrical in the second lobe; rarely with auxiliary lobes. Aptychus (?).

Hamites may include all the unwhorled Ammonitæ of the

Cretaceous, with the exception of Scaphites, Turrilites and Baculites. Neumayr has divided them into two groups: Hamites, applying to the species approaching Lytoceras by their ornamentation, and their sutural line having lobes symmetrically divided into pairs; Crioceras, containing the forms having the ornamentation of Acanthoceras, with lobes not symmetrically divided. Fischer arranges them in the following subgenera or sections, some of which are considered genera by other systematists:

MACROSCAPHITES, Meek, 1876. Shell with inner turns merely in contact, or so slightly embracing as to leave a very large, shallow umbilicus; periphery rounded; body portion much extended from the inner volutions; surface costate. *S. gigas*, Sowb.

ANCYLOCERAS, d'Orb., 1842. Shell at first spiral, discoidal with separated whorls; afterwards produced at a tangent and then bent back again upon itself like a hook. 41 sp. Infer. Oolitic, Cretaceous; Europe, South America, United States. *H. spinigerus*, Sowb. (xxxii, 33). Gault, Folkestone.

ANISOCERAS, Pictet, 1854. Shell at first spiral, helicoid, whorls separated, at length more or less prolonged and reflected; transversely ribbed; sutures of septa with five lobes and saddles, all bipartite. 12 sp. Gault to Upper Greensand; Europe. Cretaceous, Jurassic; India. *H. Saussureanus*, Pictet (xxxii, 34).

HAMITES, Parkinson (restricted). Shell conical, hook-shaped, bent upon itself more than once, the courses separate. 38 sp. Chalk; Europe, S. America.

HAMULINA, d'Orb., 1849. Differs from Hamites in being only once bent upon itself, not in contact. 20 sp. Neocomian; France. Gault (?); India. *H. trinodosa*, d'Orb. (xxxiii, 42).

PTYCHOCERAS, d'Orb., 1840. Shell bent once upon itself; the two straight portions in contact. 8 sp. Neocomian to Cretaceous; Europe, India, United States. *H. Emericianus*, d'Orb. (xxxiii, 43). France.

DIPTYCHOCERAS, Gabb, 1869. Three straight limbs in contact. A Ptychoceras in every respect except that it has an additional limb which incurves, enveloping both the preceding to a slight degree only. Meek considers it doubtfully identical with Ptychoceras.

TOXOCERAS, d'Orb., 1840. (*Toxon*, a bow, *ceras*, a horn.) Shell horn-shaped or curved; the six lobes and saddles of the sutures simply crenulated; last chamber large. Connected with Crioceras and Ancyloceras by numerous intermediate forms. 20 sp. Neocomian; France. *H. bituberculatus*, d'Orb. (xxxii, 32).

CRIOCERAS, Leveillé, 1836. Shell discoidal, whorls not contiguous, but in the same plane. 13 sp. Neocomian to U. Greensand; Europe. Some of the species are believed to be merely

incomplete Ancyloceræ. *H. cristatus*, d'Orb. (xxxii, 29). Gault; Southern France.

TURRILITES, Lam., 1801.

Etym.—*Turris*, a tower, *lithos*, a stone.

Distr.—37 sp. Gault to Chalk; Europe. *T. costatus*, d'Orb. (xxxiii, 37). *T. Boblayi*, d'Orb. (xxxiii, 38).

Shell spiral, depressed to elongate, sinistral; sutures six-lobed, foliated; aperture often irregular.

The animal of Turrilites was perhaps dibranchiate by the atrophy of the respiratory organs of one side.

HETEROCERAS, d'Orb., 1847. Shell like Turrilites, but last chamber somewhat produced and recurved. 5 sp. Cretaceous; Europe, United States. *T. Emericii*, d'Orb. (xxxiii, 39).

HELICANCYLOCERAS, Gabb, 1869. Spire less elevated, volutions less decidedly in contact.

HELICOCERAS, d'Orb., 1842. (*Helix* [*helicos*], a spiral, *ceras*, a horn.) Shell spiral, sinistral; whorls separate; annular costæ passing uninterruptedly over the siphonal side. 11 sp. Inferior Oolitic (?) to Cretaceous; Europe, India, United States.

PATOCERAS, Meek, 1876. Costæ interrupted on the siphonal side, leaving a narrow, smooth space along the whole length of the same. *T. Teilleuxii*, d'Orb. (xxxiii, 36). Jurassic.

BACULITES, Lam., 1801.

Etym.—*Baculus*, a staff. *Syn.*—Cyclomera, Conrad, 1866.

Distr.—20 sp. Cretaceous; Europe, Chili, India, United States. *B. anceps*, Lam. (xxxii, 30). France. *B. baculoides*, d'Orb. (xxxii, 31).

Shell straight, elongated, conical; suture foliately lobed; last chamber large; margin of aperture dorsally produced.

The baculite limestone of Normandy is so called from the numerous remains of the shells of this animal which it contains.

Conrad has given the name Cycloceras to a Baculite figured by him, but without generic characters; afterwards, finding that name preoccupied by M'Coy, he changed it to Cyclomera, still giving no diagnosis.

Meek divides Baculites into two subgeneric forms, which, he remarks, are possibly distinct genera.

BACULITES, Lam. (typical). *a.* Shell straight throughout; aperture directed forward; lip with lateral sinuses directed backward; the projection of its siphonal margin, straight, and its antisiphonal margin convex in outline; interior without regularly disposed ridges. *B. vertebralis*, Lam.

(?) *b.* Shell straight posteriorly, but with the non-septate part gently arcuate; aperture a little oblique; appendage of siphonal side of lip arching slightly with the general curvature of the non-

septate part, but not curving over the aperture. *B. incurvatus*, Dujardin.

CYRTOCHILUS, Meek, 1876. Shell straight; aperture opening towards the antisiphonal side, and the lateral sinuses of the lip excavated in the opposite direction; projection of siphonal margin of lip abruptly arching over the aperture, and the antisiphonal margin of same deeply sinuous instead of convex in outline; interior with regularly disposed ridges, leaving oblique constrictions on internal casts. *Hamites baculoides*, Mantell = *B. obliquatus*, Sowb.

BACULINA, d'Orb., 1847.

Distr.—2 sp. Jurassic, Lower Chalk; Europe. *B. arcuaria*, Quenstedt (xxxii, 24).

Shell straight, point conical; sutures of septa a row of rounded lobes, toothed at base.

Class PTEROPODA.

Mollusk naked, or protected by an external or internal, testaceous or membranaceous shell of variable form, with or without operculum. They are essentially pelagic, furnished with a foot dilated on each side into a large aliform expansion suitable for swimming; or having only a rudimentary foot, but with accessory locomotive organs, represented by two lateral swimming disks. In swimming the body is nearly reversed in position, the abdomen being uppermost. The more or less distinct head has one or two pairs of tentacles. Mouth terminal or subterminal, with lingual armature, and sometimes organs of prehension and of mastication. Branchiæ, either external or contained within an interior cavity. The sexes are united in the same individuals, but the male organ is separated from the female. Carnivorous.

The pteropods are all small mollusks, some of them even microscopic; they are commonly known as sea-butterflies and whale-food. The first of these names has been given on account of the form and incessant movement of their swimming lobes; the second because they form a portion of the food of the Balæna and other cetaceans, as well as of a great number of fishes. The pteropods live at a certain depth beneath the surface, and only approach shores by accident, or when carried by storm or current.

The Pneumodermon, Clio and large species of Cleodora usually appear at night only, and some only when the night is very dark; and d'Orbigny supposed that it is only when the degree of obscurity at the surface approximates to that which the animal habitually perceives in its daylight habitation, that it rises at all; certain it is, says he, that so soon as the sun appears, not a pteropod is to be seen. Later observers, however, have established the fact that specimens may be obtained from the surface of the ocean at all hours of the day, although they are mainly crepuscular in habit.

These little animals are eminently sociable, forming considerable masses in the regions which they inhabit. They occur in all seas, but most of them are found in temperate and tropical latitudes, whilst a few forms are restricted to the Arctic seas. Contrary to the usual fact among mollusca, the Arctic species are here the most highly colored; due to the transparence of their shell, which partly shows the viscera.

Pteropods live upon microscopic animals, and possibly small mollusks, such as Atlanta and crustaceans. A few of them possess organs of prehension, but it is difficult to indicate the means by which the most of them seize their prey.

Among the pteropods some have an external or internal shell

which is either testaceous or membranaceous, whilst others are naked. They all possess a heart, composed of auricle and ventricle, within a pericardium. Their organs of sense are very restricted: they have no eyes; at least the little black points formerly considered visual organs, M. Souleyet has ascertained to be hearing pouches, having no exterior opening. The mouth is more or less developed and is furnished with a lingual ribbon, and the olfactory organ has its seat in the tentacles.

The *Cavolina tridentata* oviposits at sunset. Its eggs are enveloped in a very smooth and elastic glairy ribbon, presenting a series of pouch-like enlargements. The Thecosomoid species, *Cymbulia Peronii*, lays its eggs at any hour of the day: they are enveloped in a glairy cylindrical mass, containing a few partitions or chambers, each of which may include forty eggs; several of these masses may be laid during a day, and the whole will amount to about twelve hundred eggs.—FOL., *Archives Zool. Exp.*, iv, 1875.

The larval pteropods are furnished with a velum, which disappears a short time after the appearance of the adult swimming organs. In the earlier phases of their development a shell always exists; even in those genera in which the adult is naked, *i. e.* without shell.

The Pteropoda are considered by some naturalists as a subordinate group of the Gastropoda, and they are certainly much more closely allied to the latter than to the Cephalopoda; but their pelagic habit and organization appear to indicate a distinct class. Their geological record does not sustain the views of those who look upon them as gastropods arrested in development, for the type occurs in the primordial fauna; moreover, they have a temporary velum, so that the wings do not represent that organ of the Gastropoda.

ORDER THECOSOMATA.

Etym.—*Theke*, a case, *soma*, a body.

Animal furnished with an external shell, which is sometimes cartilaginous; head indistinct; foot and tentacles rudimentary, combined with the fins; mouth situated in a cavity formed by the union of the locomotive organs; respiratory organ contained within a mantle cavity, either dorsal or ventral.

FAMILY HYALEIDÆ.

Shell straight or curved, never spiral, globular or needle-shaped, symmetrical. No operculum.

Animal with two large fins, attached by a columellar muscle passing from the apex of the shell to the base of the fins; body enclosed in a mantle; gill represented by a transversely plaited

and ciliated surface, within the mantle cavity, on the ventral side; lingual teeth (of Hyalea) 1·1·1, each with a strong recurved hook (xii, 55).

HYALEA, Lamarck, 1799.

Etym.—*Hyalëos*, glassy.

Syn.—Cavolina, Gioeni (not Brug.), 1783.

Distr.—19 sp. Atlantic, Mediterranean, Indian Ocean. *H. tridentata*, Gmel. (xlii, 1). *H. quadridentata*, Les. (xlii, 2). Fossil, 10 sp. Miocene; Sicily, Turin, Dax, Azores.

Shell globular, translucent; dorsal plate rather flat, produced into a hood; aperture contracted, with a slit on each side; posterior extremity tridentate.

Animal with long appendages to the mantle, passing through the lateral slits of the shell; tentacles indistinct; fins united by a semicircular ventral lobe, the equivalent of the posterior element of the foot.

The long, loose, lateral, pallial prolongations, which the testaceous pteropods protrude from the lateral fissures of the shell, do not appear to be of much use in guiding or propelling, which functions are performed by the wide alar expansions. They may assist, however, in extending the surface of the mantle for the purpose of aëration.—A. ADAMS, *Narr. Voy. Samarang*, ii, 522.

GAMOPLEURA, Bellardi, 1881. Shell laterally impervious. *H. Taurinensis*, Sismonda. Tertiary; Piedmont.

DIACRIA, Gray, 1840. (Pleuropus, Esch., 1825.) *H. trispinosa*, Less. (xlii, 7, 8.) Shell tricuspidate, the terminal point long; with lateral slits opening into the cervical aperture.

CLEODORA, Peron and Lesueur, 1810.

Syn.—Clio, Linn. (part), Browne, not Müller.

Distr.—12 sp. Atlantic, Mediterranean, Indian Ocean, Pacific, Cape Horn. *C. compressa*, Eyd. (xlii, 3). Fossil, 4 sp. Miocene—; Britain. *C. infundibulum*, Crag.

Shell pyramidal, three-sided, striated transversely; ventral side flat, dorsal keeled; aperture simple, triangular, with the angles produced; apex acute.

Animal with tentacles obsolete; mantle processes short or absent; fins ample, bilobed, united ventrally by a rounded lobe; lingual teeth 1·1·1. The transverse bars of the gills, the heart, and other organs are visible through the pellucid shell.

BALANTIUM (Leach), Gray, 1847. Shell triangular, depressed, transversely undulated; mouth oblong, oblique, narrow. Animal similar to Cleodora. *B. recurvum*, one of the handsomest of the pteropods, swims steadily, instead of flitting about in the lively manner of the Hyalæa. *C. inflata*, Eyd. (xlii, 4, 5).

FLABELLULUM, Bellardi, 1871. Shell transversely undulated

and rugose; dorsal surface longitudinally ribbed; lateral margins rectilinear. 3 sp. Miocene; northern Italy.

POCULINA, Bellardi, 1871. Surface not transversely undulated; lateral margins slightly convex. 3 sp. Miocene; northern Italy.

EUCHILOTHECA, Fischer, 1882.

Distr.—*Cleodora Parisiensis*, Desh. Eocene; Paris.

Shell narrow, conically subulate, apex subinflated, ovoid, mucronate, not septate within; aperture ovate, horizontal, not oblique, margin externally reflected, sometimes bilabiate.

HYALOCYLIX, Fol., 1875.

Distr.—*H.* (*Cleodora*) *striata*, Rang. Mediterranean, Atlantic.

Shell conic, slightly depressed, transversely grooved; aperture oval, not oblique; summit acuminated. Animal with bilobed wings.

STYLIOLA, Lesueur, 1826.

Syn.—Creseis, Rang, 1828.

Distr.—6 sp. *S. subulata*, Quoy (xlii, 6).

Slender, conical, pointed, straight, or curved. Fins rather narrow, truncate, with small tentacles projecting from their dorsal edges, and rudiments of the mesopodium on their surface; mantle-margin with a spiral process on the left side. M. Rang states that he has seen these pteropods clustering round floating seaweed.

Mr. Arthur Adams has observed them, during a calm in the Atlantic towards the decline of day, shining near the surface like myriads of glassy spicula; they often remain posed and motionless, and their progression through the water is very irregular.

Barrande has seen a triangular operculum in connection with *H. striatus*, as well as similar bodies with other species.

CUVIERIA, Rang, 1827.

Dedicated to Baron Cuvier.

Distr.—4 sp. Atlantic, India, Australia. *C. columella*, Rang (xlii, 9). Fossil, 4 sp. Miocene and Pliocene; Turin, Calabria.

Shell cylindrical, transparent; aperture simple, transversely ovate; apex acute in the young, afterwards partitioned off, and usually deciduous, so that the end of the shell is blunt or truncate.

Animal with simple narrow fins, united ventrally by two small lobes; lingual teeth 1·1·1.

VAGINELLA, Daud, 1802. Shell oblong, with a pointed apex; aperture contracted, transverse. Fossil, 4 sp. Miocene; Bordeaux, Turin. *C. depressa*, Daud (xlii, 32).

The genus Triptera, Quoy and Gaimard, 1824, was founded on a fragment of a Cuvieria.

HYOLITHES, Eichw., 1840.

Syn.— Theca, Morris, 1845. Pugiunculus, Barrande, 1847. Cleidotheca and Centrotheca, Salter, 1866.

Distr.—Fossil, 40 sp. Palæozoic; North America, Europe, N. S. Wales. *H. fasciculatus* (xlii, 11).

Shell straight, conical, tapering to a point, back flattened, aperture trigonal. Length, 1–8 inches.

HYOLITHELLUS, Billings. Differs from Hyolithes in its long, slender form and in the peculiar structure of the operculum. *H. micans*, Billings (xlii, 12). Palæozoic; N. America. It may be a Salterella. *a* represents the rate of tapering of the shell on its ventral side, and the included figure its apical portion; *b* is the inner surface of the operculum, enlarged 2–1, showing radiating muscular impressions.

CLATHROCŒLIA, Hall, 1879. Shell thinner than Hyolithes, interior cancellated by longitudinal striæ crossing the arcuated septal lines. *H. Eborica*, Hall. Devonian; U. S.

PTEROTHECA, Salter, 1852.

Syn.—Clioderma, Hall, 1861.

Distr.—*P. transversa*, Portlock. 8 sp. Silurian; Ireland, Wales, Canada, Bohemia.

Shell bilobed, transversely oval, with a dorsal keel projecting slightly at each end; ventral plate small, triangular.

CYRTOTHECA, Hicks. Shell with curved apex; a longitudinal ridge extends along the surface of the sides near the centre; but the surface is otherwise tolerably smooth; mouth funnel-shaped with one lip greatly elongated. *P. hamula*, Hicks (xlii, 13). Cambrian; Gt. Britain.

STENOTHECA, Hicks. Curved, wide, with the lines of growth strongly marked on the surface. *P. Cornucopiæ*, Hicks (xlii, 14). Cambrian; Gt. Britain.

SCENELLA, Billings. Has a smoother surface. Palæozoic; Newfoundland.

PHRAGMOTHECA, Barrande, 1867.

Distr.—*P. Bohemica*, Barrande. Upper Silurian; Bohemia.

Shell like that of Pterotheca, but having septa. Differs from the cephalopods, which are chambered, in the want of a siphuncle.

CONULARIA (Miller), Sowerby, 1818.

Etym.—*Conulus*, a little cone. *Syn.*—Conulites, Schloth.

Distr.—Fossil, about 100 sp. Silurian to Carb.; N. America, Europe, Australia. *C. Geroldsteinensis* (xlii, 15).

Shell four-sided, straight, and tapering, the angles grooved, sides striated transversely, apex partitioned off. The Conulariæ were the giants of the Pteropoda; *C. inornata*, Dana, of Australia, is supposed to have been 16 inches long.

COLEOPRION, Sandberger. Shell round, tapering, sides obliquely striated, striæ alternating along the dorsal line. *C. gracilis*, Sandb. Devon.; Germany.

COLEOLUS, Hall, 1879. Shell tubuliform, straight or slightly curved, rather thick, smooth within; surface more or less obliquely grooved, and sometimes longitudinally striate. *C. aciculus*, Hall. Devonian; U. S.

HERMICERATITES, Eichwald, 1840.

Distr.—Fossil, 3 sp. Middle Silurian; Russia.

Shell cylindrical or semicylindrical, elongated, straight, with a dark brown corneous epidermis, furnished with a straight, median siphuncle, which does not traverse any chambers.

Very doubtful pteropods; might as well be referred to Cephalopoda.

SALTERELLA, Billings, 1861.

Dedicated to Mr. J. W. Salter, late Palæontologist to the Geological Survey of Great Britain.

Distr.—Fossil, 3 sp. Lower Silurian; Canada.

Shell small, slender, conical, straight, consisting of many cones placed one within the other; the transverse section of the tubes is circular or subtriangular; the surface is transversely or longitudinally striated. This is very probably an Annelid; as is also Tentaculites, Schloth.

FAMILY CYMBULIIDÆ.

Animal oval, with large rounded wings. Dentition 1·1·1; the central tooth very large, the laterals wide at the base, unicuspid.

Shell symmetrical, subinternal, cartilaginous, slipper-like. Embryos with a caducous, operculated, testaceous, spiral shell.

CYMBULIA, Peron and Lesueur, 1810.

Etym.—Diminutive of *cymba*, a boat.

Distr.—3 sp. Atlantic, Mediterranean, Indian Ocean. *C. proboscidea*, Peron (xlii, 17).

Shell cartilaginous, slipper-shaped, spinous, pointed in front, truncated posteriorly; aperture elongated, ventral.

Animal with large rounded fins connected ventrally by an elongated lobe; mouth furnished with minute tentacles; stomach muscular, armed with two sharp plates.

TIEDEMANNIA, Chiaje, 1839.

Named after Fr. Tiedemann. *Syn.*—Gleba, Forskal.

Distr. — 3 sp. Mediterranean, Australia. *T. Neapolitana*, Chiaje (xlii, 18).

Animal naked, transparent, fins united, forming a large rounded

disk; mouth central; tentacles elongated, connate; eye-tubercles minute. Larva shell-bearing.

COROLLA, Dall, 1871. Like Tiedemannia, but with the body pendant below, unattached to the pinnæ, ovoid, constricted above; œsophagus produced, aperture trumpet-shaped, produced into two points; pinnæ forming a single disk with reticulated muscular bands, separated by a deep sinus from the oral portion. No shell. *T. spectabilis*, Dall. N. Pacific Ocean.

FAMILY LIMACINIDÆ.

Shell minute, spiral, sinistral, calcareous. Operculum pauci-spiral, vitreous.

Animal with fins attached to the sides of the mouth, and united ventrally by an operculigerous lobe; mantle-cavity large, opening dorsally; excretory orifices on the right side.

The shells of the true Limacinidæ are sinistral, by which they may be known from the fry of Atlanta, Carinaria, and most other gastropods.

LIMACINA, Cuvier, 1817.

Etym.—Limacina, snail-like. *Syn.*—Spiratella, Bl., 1824.

Distr.—2 sp. Arctic and Antarctic Seas; gregarious. *L. Antarctica*, Forbes (xlii, 20).

Shell subglobose, sinistrally spiral, umbilicated; whorls transversely striated; umbilicus margined.

Animal with expanded fins, notched on their ventral margins.

VALVATELLA, Mörch, 1874.

Syn.—Planorbella, Gabb, 1872 (not Haldeman).

Distr.—Tertiary; Sicily, Denmark, West Indies. *V. atlanta*, Mörch. *P. imitans*, Gabb.

Shell minute, vitreous, sinistral, apex sunken as in Planorbis. The type, a West Indian fossil, might be taken for a young specimen of *Planorbis trivolvis* were it not sinistral.

SPIRIALIS, Eydoux and Souleyet, 1840.

Syn. — Heterofusus, Fleming, 1825. Heliconoides, d'Orb. Peracle, Forbes. Scæa, Ph., 1844.

Distr.—12 sp. Greenland and Norway to Cape Horn, Indian Ocean, Pacific. *S. ventricosa*, Eyd. (xlii, 21). Fossil. Eocene; Paris basin. Pliocene; Sicily, Rhodes.

Shell minute, hyaline, sinistrally spiral, globose or turreted, imperforate or narrowly perforated, smooth or reticulated; operculum thin, glassy, semilunar, slightly spiral, with a central muscular scar.

Animal with narrow, simple fins, united by a simple, transverse operculigerous lobe; mouth central, with prominent lips.

ds are infrequent visitors to our coasts; *Spirialis* r, occurred at Nahant, Mass., in great abun- mer of 1863. Mr. Alexander Agassiz gives f its habits:

urface of the water about an hour after remain long, and after ten o'clock at night ith. He succeeded only once in finding a few ns during the heat of the day; while at full tide, s, they were very often found in abundance. These very easily kept in captivity, and their habits, which be carefully watched, may explain in a very satisfactory their sudden appearance and disappearance. They creep by means of their wing-like appendages. They but rarely t the bottom during the day, merely rising a few inches, and then falling down again to the bottom of the jar. After dark, however, they could all be seen in great activity, moving near the surface of the water as fast as their appendages enabled them. During the day, they often remain suspended for hours in the water, simply by spreading their wing-like appendages, and then suddenly drop to the bottom on folding them. When the animal is in motion, beating the water like a butterfly to propel itself forwards or upwards, the shell is carried at right-angles, hanging somewhat obliquely to the direction of the movement.—*Bost. Proc.*, x, 14.

HELICONOIDES, d'Orb., 1839. (Protomedea, Costa, 1861. Embolus, Jeffreys, 1869.) Shell thin, transparent, discoidal, sinistral, axis umbilicated; whorls smooth; peristome disunited, notched on each side, and with an elongated, arched beak in front. *S. inflata*, d'Orb. (xlii, 22).

EUROMUS, H. and A. Ad., 1858. Shell oblong, not turreted, cancellated; spire short, obtuse, last whorl swollen, much larger than the others; aperture large, elongate. *S. clathrata*, Eyd. (xlii, 23).

PERACLE, Forbes, 1844. Shell oblong, not turriculated, spire rather short, aperture prolonged into a long, curved canal. 2 sp. European seas. *S. physoides*, Forbes.

AGADINA, Gould, 1852.

Distr.—*A. cucullata*, Gld. (xlii, 24).

Shell colorless, pellucid, planorbular, one side showing five or six whorls, the other a single volution with a large umbilical pit; aperture oblique, campanulate, and projecting beyond the last whorl like a hood.

The single species was found floating near an iceberg in 60° S. latitude and 106° 20′ E. longitude. The animal is black, with oval appendages, not lobed.

Order GYMNOSOMATA.

Animal naked, without mantle or shell; head distinct; fins attached to the sides of the neck, without intermediate lobe; gills indistinct (Clio), or distinct (Pneumodermon); teeth numerous.

The embryos are at first Thecosomous, having a straight shell, ovoid at the extremity; they swim by means of a ciliated velum; subsequently, they lose the shell, and the body is encircled by rings of ciliæ (xx, 53, 55), which in turn disappear as the animal assumes its perfect form.

Family CLIIDÆ.

Body fusiform; head with tentacles often supporting suckers; foot small, but distinct, consisting of a central and posterior lobe.

Clio (L.), Müller, 1776.

Etym.—*Clio*, a sea-nymph. *Syn.*—Clione, Pallas, 1774.

Distr.—10 sp. Arctic and Antarctic Seas, Norway, Mediterranean, India.

Head with two eye-tubercles and two simple tentacula; mouth with lateral lobes, each supporting two or three conical retractile processes, furnished with numerous microscopic suckers; fins ovate; foot lobed. Dentition 12·1·12. In swimming, the Clio brings the ends of its fins almost in contact, first above and then below (Scoresby).

C. borealis (xlii. 2, 5) is largely the food of whales; the Clio and other pelagic animals are attracted to the large bodies of Diatomaceæ which discolor the Arctic seas, and on which they feed. The whale in turn lives upon them, and whalers hail the appearance of these discolored patches of ocean-surface as indicative of a good oil-harvest.

CLIODITA, Quoy and Gaimard. Head supported on a narrow neck; tentacles indistinct. 4 sp. Cape, Amboyna. *C. fusiformis.*

Clionopsis, Troschel.

Distr.—*C. Krohnii*, Trosch. (xlii, 26). Mediterranean Sea.

Body ovate, head keeled, mouth armed with three jaws; two lateral tentacles; fins two, oblong, lateral, anterior, with a truncate intermediate lobe; a ciliated ring around the hinder part of the body.

The ciliated ring around the base of the head, and similar ring around the middle of the body, seen in Trichocyclus (Pneumodermon), are wanting in this genus.

Pneumodermon, Cuvier, 1804.

Etym.—*Pneumon*, lung (or gill), *derma*, skin.

Distr.—4 sp. Atlantic, Indian, Pacific Ocean. *P. Peronii*, Lam. (xlii, 27).

Body fusiform; head furnished with ocular tentacles; lingual teeth 4·0·4; mouth covered by a large hood supporting two small, simple, and two large acetabuliferous tentacles, suckers numerous, pedicillate, neck rather contracted; fins rounded; foot oval, with a pointed posterior lobe; posterior extremity of the body truncate, with small branchial processes, and a minute rudimentary shell (?).

In captivity not shy, but swims actively; when touched folds its fins upon its body and falls to the bottom, rolled up into a little ball.

SPONGIOBRANCHÆA, d'Orb., 1840. Gills forming a spongy ring at the end of the body; tentacles each with six rather large suckers. *Distr.*—1 sp. *P. australis*, d'Orb. (xlii, 28). South Atlantic (Fry of Pneumodermon ?). *S. elongata*, d'Orb., is a Clio.

PNEUMODERMOPSIS, Bronn, 1862. Branchiæ at the extremity of the body. *P. ciliatum*, Gegenbauer.

TRICHOCYCLUS, Esch., 1825. Head elongated, trunk-like, with two lateral tentacles; two lateral swimming lobes, and an intermediate lanceolate one; branchiæ in a ciliated ring upon the middle of the body; two similar ciliated rings, one at the base of the head, the other at the truncated posterior extremity of the body. *P. Dumerilii*, Esch. (xlii, 29). Probably larvæ.

(?) PELAGIA, Quoy and Gaimard.

Etym.—*Pelagus*, the deep sea.

Syn.—Pteropelagia, Bronn, 1862.

Distr.—*P. alba*, Quoy (xlii, 30). Amboina.

Animal fusiform, truncated in front, rough; head with two tentaculiform tubercles; neck slightly contracted; fins small, fan-shaped.

Supposed by Souleyet to be very close to Clio.

(?) CYMODOCEA, d'Orbigny, 1840.

Etym.—*Kumodoke*, a Nereid.

Distr.—*C. diaphana*, d'Orb. (xlii, 32). Atlantic.

Animal fusiform, truncated in front, pointed behind; neck slightly contracted; fins two on each side, first pair large and rounded, lower pair ligulate; foot elongated; mouth proboscidiform, four-lobed. The animal is translucent, showing the violet viscera.

CIRRIFER, Pfeffer, 1879.

Distr.—*C. paradoxus*, Pfeffer. Tropical Atlantic.

Body oblong, head distinct; superior tentacles small, anterior tentacles long, bifid and thickened towards the end.

Family EURYBIIDÆ.

Animal short, rounded; head distinct, retractile into a pouch formed by a thickening of the mantle; wings long and narrow. Dentition 1·1·1 according to Macdonald, 1·0·1 according to Souleyet and Huxley.

Eurybia, Rang, 1827.

Etym.—*Eurybia*, a sea-nymph. *Syn.*—Theceurybia, Bronn.

Distr.—4 sp. Atlantic and Pacific. *E. Gaudichaudi*, Eyd. (xlii, 16).

Animal globular; fins narrow, truncated, and notched at the ends, united ventrally by a small lobe (metapodium); mouth with two elongated tentacles, behind which are minute eye-peduncles and a two-lobed rudimentary foot (mesopodium); body enclosed in a cartilaginous integument, with a cleft in front, into which the locomotive organs can be retracted.

The animal has no proper gill, but Mr. Huxley has observed two ciliated circles surrounding the body, as in the larva of Pneumodermon.

Psyche, Rang, 1825. (Halopsyche, Bronn, 1862.) Animal globular, with two simple oval fins, and no tentacles. *P. globulosa*, Souleyet (xlii, 10). Off Newfoundland.

Aspidella, Billings, a very doubtful fossil from the Huronian of Newfoundland, has been referred to the Pteropoda by S. A. Miller in his Am. Pal. Fossils. *A. terranovica*, Bill. (xlii, 19).

Class GASTROPODA.

Head distinct, usually furnished with eyes and tentacles; body mostly protected by a spiral or conical univalve shell; lower surface of animal developing a thickened, expanded, creeping disk or foot.

The following subclasses conveniently separate the immense number of molluscan types having the gastropod structure:

Subclass PROSOBRANCHIATA. Sexes separate, in different individuals. Mostly marine animals, provided with a shell and generally, an operculum — at least all operculated mollusks belong to this group. The animal breathes by gills or branchiæ.

Subclass OPISTHOBRANCHIATA. Marine slugs breathing by arborescent or fasciculated branchiæ, which are more or less completely exposed on the back and sides, towards the posterior end (*opisthen*) of the body. A large division of the Opisthobranchiates is shell-less; another possesses a spiral, conical or lamellar shell, partially concealing the branchiæ, and itself more or less concealed by the mantle-lobes. Sexes united.

Subclass PULMONIFERA. Sexes united in the same individual. Mostly terrestrial (a portion being fluviatile) mollusks, usually provided with a shell, without operculum; breathing air by the simplest form of lung, a pouch with external opening, lined with a network of respiratory vessels.

The pulmonifera are closely related to the plant-eating sea-snails (holostomata), through Cyclostoma, and to the nudibranchs by Oncidium. As a group, they are generally inferior to the sea-snails, on account of the comparative imperfection of their senses, and the union of the functions of both sexes in each individual.

Subclass PROSOBRANCHIATA.

The prosobranchiates are typically marine animals, but there are many exceptions to the rule; for not only do we find a certain number of genera inhabiting brackish water, but some live in fresh water only, and others again are terrestrial. It is not without some modification of the breathing organs that such diversity of station exists, and this modification is coexistent with other adaptations.

Whilst the pulmoniferous mollusks have no operculum, the terrestrial and fluviatile sections of the prosobranchiates are provided with a very efficient one, completely closing the aperture of the shell. The canaliculate aperture, the operculum usually too small to fill this aperture, and, frequently, the want of an operculum are characteristic of the major portion of the proso-

branchiates—the marine zoophaga, whilst the rounded aperture and its efficient operculum belong to the phytophagous groups. In going over the genera of marine prosobranchiates another general law appears to coexist with the foregoing divisions, namely, that the zoophaga are the most active, and are frequently deep-sea animals, whilst the phytophaga are necessarily more confined to shallow water, between tides, etc., where their food is more readily obtainable. Some of the zoophaga prefer a rocky station, whilst others affect sandy or muddy bottoms; the little genus Stylifer is parasitic upon echini, etc., immersed in which it dwells, and some other genera habitually seek special stations, as Pedicularia and Magilus upon corals, certain Vermetidæ upon other shells, etc. On the other hand, numerous animals dwell upon and within the substance of the shells of univalve mollusca, including sponges, worms, corals, molluscoids, etc., not to mention many of the true mollusca, and especially bivalve species.

Bronn has prepared the following synoptical table of the number of genera and species of prosobranchiates occurring in each geological formation; aggregating 7123 species: it would be largely increased, but its relative proportions probably not much changed, by the incorporation of material since made known to science.

PALÆOZOIC. 737 species. 57 genera.	Silurian,	164	species,	11	genera.
	Devonian,	244	"	20	"
	Carboniferous,	312	"	26	"
	Permian,	17	"		
SECONDARY. 1764 species. 166 genera.	Triassic,	393	"	36	"
	Jurassic,	488	"	56	"
	Cretaceous,	883	"	74	"
TERTIARY, ...		4622	"	179	"

The relations of the tertiary with the recent mollusca are daily appearing to be more intimate. It is probable that a very considerable proportion of its species will be found to be synonymous with existing forms, and that the more comprehensive views of nature which have now obtained (and which are the happy result of the development theory—whatever may be said of the justness of its ultimate conclusions), will enable us to make proper allowances for influences producing variation in fossils as we do in recent species. Time has not been the only factor: as many of our so-called extinct species are obtained from particular local deposits, their characteristics, probably, are frequently more local and varietal than specific. Hundreds cases might be cited of variations from a known specific type

of recent mollusks, where the differences are much greater than those which palæontologists, seeking distinctive characters for their periods or formations, have been accustomed to consider as of specific and even generic value.

Bronn has also prepared a table of the number of species of each genus of prosobranchiates appearing in the various formations, with the totals of species, fossil and recent, appertaining to each. As in his table just quoted, much allowance must be made for increase of species made known since his publication. The genera are within the Lamarckian limits.

Number of Species.

	Silur.	Devon.	Carb.	Perm.	Triassic.	Juras.	Cret.	Tertiary.	Total fossil.	Recent species.	Total species, fossil and recent.
CHITON...........		18		1	1			11	81	200	281
PATELLA..........	6	19	1		2	16	10	88	98	100	198
FISSURELLA.......		2					5	23	30	84	114
EMARGINULA.....						4	7	23	34	26	60
CAPULUS..........	1	10			1			12	24	7	31
PILEOPSIS.........	2	9					4	23	40		40
CREPIDULA								16	16	40	56
CALYPTRÆA......								11	11	50	61
SIGARETUS........		3						12	15	26	41
NATICA...........	5	20		1	6	23	56	88	230	100	330
NERITA...........	3	8				7	2	30	52	120	172
NERITINA.........		1				1		30	34	100	134
AVELLANA........							13		13		13
NERINÆA.........						56	46		92		92
TURBONILLA......		9		1				22	32		32
LOXONEMA	2	20		1					23		23
MACROCHEILUS....	1	14	1	1					17		17
SCALARIA		1				1	18	80	100	100	200
TURRITELLA......	4	29	4	1	6	17	71	107	296	30	326
PHASIANELLA.....		5			1	2	9	11	29	22	51
LITTORINA.......	1	2	2			3	8	15	31	60	91
TURBO...........	18	32	1	2	8	50	58	57	264	75	339
DELPHINULA......		2				7	4	36	55	30	85
EUOMPHALUS.....	28	60				2			90		90
SOLARIUM........						2	34	65	102	25	127
ROTELLA...... ...		4				4	1	4	15	10	25
PHORUS..........							3	14	17	7	24
TROCHUS.........	5	21	1	3	1	66	51	178	362	160	522
MURCHISONIA....	18	30		1					48		48
SCHIZOSTOMA.....	4	13							17		17
PLEUROTOMARIA..	28	128		5	1	41	63	2	310	2	312
CIRRUS		2	1			7	1		14		14
CERITHIUM.......		1	1				36	327	367	90	457
ROSTELLARIA.....					4	14	60	16	94	6	100
PTEROCERAS......						11	17		27	10	37
STROMBUS.........							5	31	36	70	106
MUREX						5	13	179	187	210	397
FUSUS............		1			1	7	53	290	357	100	457
PYRULA..........	1	2					17	36	56	40	96
PLEUROTOMA.....							6	344	350	370	720
FASCIOLARIA.....							2	32	34	15	49
CASSIS...........						1		35	36	35	71
BUCCINUM		7	3		1	15	5	142	173	100	273
TEREBRA.........						5	2	30	37	110	147
VOLUTA..........							13	93	106	70	176
MITRA...........							2	110	112	350	462
OLIVA...........								32	32	120	152
CYPRÆA.........							3	79	92	160	242
CONUS...........							3	89	92	270	362
Total.........	127	473	15	17	33	367	701	2788	4516	3500	8016

The prosobranchiates may be divided into the following orders:

Order PECTINIBRANCHIATA.

The mollusks of this group have pectiniform branchiæ; that is, composed of leaflets arranged like the teeth of a comb, in one or two series or lines, and situated upon the upper wall of a respiratory cavity formed by the mantle, having an external opening upon the side of the neck. Sexes separated, in different individuals (diœcious). The shell is spiral.

Order SCUTIBRANCHIATA.

Branchiæ pectinated, placed in a cavity in the upper part of the neck, or at the inferior edge of the mantle, around the foot. Diœcious usually. Shell spiral (globular or pyramidal) or conical, holostomate, or with entire margins without anterior canal.

Order POLYPLACOPHORA.

Shell multivalve, consisting of eight separate pieces inserted upon the back of the animal and surrounded by a mantle-border.

Order NUCLEOBRANCHIATA.

Pelagic animals, swimming by means of fin-like lobes of the foot; with or without a shell, the latter being glassy, transparent; branchiæ partially or perfectly developed, forming a sort of nucleus on the posterior part of the back—whence the ordinal name. Diœcious.

This small group appears to form a connection with the Nudibranchiate division of the Opisthobranchiata on the one hand, whilst on the other its specialized swimming organs and the consistency of its shell ally it to the Pteropoda.

ORDER PECTINIBRANCHIATA.

FAMILY MURICIDÆ.

Shell spiral, turriculated, with an anterior canal; the whorls thickened by varices or nodules at each rest-period in its growth. Operculum with subapical or lateral and marginal nucleus. Lingual dentition (x, 17, 19).

Subfamily MURICINÆ. Three or more varices on each whorl, the varices being nodulous, foliated or spinose; canal long or short, but well-marked.

Subfamily PURPURINÆ. Without varices, but tuberculate; columella flattened or patulous; basal canal very short or a mere notch.

SUBFAMILY *MURICINÆ*.

MUREX, Linn.

Spiny rock shell. *Syn.*—Aranea, Perry. Centronotus, Swn. Muricanthus, Swn. Muricidea, Swn. Haustellum, Klein. Brontes, Montf.

Distr.—200 sp. World-wide, mostly tropical and subtropical; low water to fifty fathoms or more. *M. tenuispina*, Lam. (xliii, 1). Fossil, 160 sp., commencing with the Eocene.

Shell ovate or oblong; spire prominent; whorls convex, crossed by three or more continuous varices; aperture ending below in a canal, which is generally partly closed.

Murex erinaceus (xliii, 10) is a well-known depredator on the oyster-beds of Europe, and is considered one of the most dangerous enemies with which the ostreiculturist has to contend. So destructive is it in the oyster-parcs of Arcachon (near Bordeaux), that it is incessantly hunted by the fishermen, who spend whole days in destroying it by removing with a knife a portion of the foot and the operculum, after which the animal is left to die at its leisure or become the prey of other carnivores. The Murex seats itself firmly upon the shell of the oyster, and applies its rostrum to the surface of the latter, invariably at a point near the beak; after which a regular movement of the body to right and left ensues during a term of three or four hours, and results in piercing a small, round hole through the oyster shell, exposing the most essential viscera to the rapacity of the patient tunneler. It is believed that the denticles of the tongue are applied to the surface to be bored, and then the gyration of the animal gradually rasps through the hole; it has been supposed by some that an acid solvent is also used in this operation, but this is only conjectural. M. Fischer has observed at Arcachon that young Murices choose young oysters, whilst adults select larger oysters. The bored oyster soon dies or else, exhausted, opens its valves, when a myriad of other animals—crabs, mollusks, worms, fishes—hasten to profit by the fruit of the winkle's labor.—*Jour. Conch.*, 5, 1865.

The ancients obtained their purple dye from species of Murex. The small shells were bruised in mortars, the animals of the larger ones taken out. Heaps of broken shells of the *M. trunculus*, and the caldron-shaped holes in the rocks where they were triturated, may still be seen on the Tyrian shore. On the coast of the Morea, there is similar evidence of the ancient employment of *M. brandaris* for the same purpose.

In the following synopsis of subgenera, the discriminative characters used separate widely groups which really appear to be closely related: thus, Cerostoma and Pteronotus are intimately allied, notwithstanding the difference of the operculum;

and Phyllonotus and Chicoreus have the same general facies, although they differ in the number of varices. Owing to their inter-relationships, no attempt to present the groups in succession can be other than exceedingly artificial.

a. Operculum with subapical nucleus.

* *Varices three.*

MUREX (typical). Shell spinous; spire elevated; canal very long, narrow, nearly straight.

PTERONOTUS, Swainson. Shell triangular; varices fin-like or foliated; canal moderate, closed, somewhat curved. *M. trigonulus*, Lam. (xliii, 2).

CHICOREUS, Montf. Shell ovate-pyriform; varices foliated and sometimes spinose; canal short, curved, wide, nearly closed. *M. adustus*, Lam. (xliii, 3).

ODONTOPOLYS, Gabb. Resembles the subgenus Pteronotus in having three varices on each whorl, but distinguished by the crenulations of the outer lip and by having two transverse plaits or folds on the middle of the columella. *M. compsorhytus*, Gabb (xliii, 4). Eocene; Wheelock, Texas.

* * *Varices four to ten.*

RHINOCANTHA, H. and A. Adams. Has the short body-whorl and long canal of the typical Murices; differs in having more numerous varices. *M. cornutus*, Linn. (xliii, 5).

HOMALOCANTHA, Mörch. Whorls rounded and sutures very deep; varices foliated, and peculiarly produced into expanded digitations; canal long. *M. scorpio*, Linn. (xliii, 6).

PHYLLONOTUS, Swains. Like Chicoreus, but varices numerous. *M. radix*, Gmel. (xliii, 7).

b. Operculum purpuroid.

* *Varices three.*

CEROSTOMA, Conrad. Varices wing-like; aperture usually dentate within the outer lip, with a produced tooth near its base. Analogous with Pteronotus. It is very difficult to define the boundary between this group and Pteronotus, inasmuch as the operculum of several of the species is not known; moreover, the labral tooth does not always appear even in those species having a purpuroid operculum. All the species with more than one inter-variceal node appear to be true Pteronoti, and the distribution of the group is mainly Indo-Pacific; Cerostoma, on the other hand, is North Pacific in distribution, extending from Japan northwards to Behring's Straits, and on the opposite American coast south to Central America. *M. Nuttallii*, Conr. (xliii, 8).

* * *Varices numerous.*

VITULARIA, Swainson. Shell oblong; spire short; body-whorl

long; canal very short, wide; outer lip thickened and dentate within. Varices nearly obsolete. *M. miliaris*, Gmel. (xliii, 9).

OCINEBRA, Leach. (Muricopsis and Corallinia, Bucq. and Dautz.) Spire elevated; canal more or less closed; varices foliated, sometimes spinose. *M. erinaceus*, Linn. (xliii, 10).

This group, as well as Muricidea, is made by Messrs. Adams an *omnium gatherum*, including true Murices, purpuroid Murices, Purpuræ, Fusidæ, etc. Muricidea as defined by them has no really distinctive characters from Ocinebra, and Swainson included species of Trophon, Triton, etc. I have suppressed Muricidea, and retained Ocinebra for a group of small Murices with numerous varices and purpuroid operculum; the species having muricoid operculum should be relegated to Phyllonotus, from which they do not differ.

PTEROHYTUS, Conrad. Not characterized. The type has lamellar varices like *Cerostoma foliatum*, but more numerous than in that group, and the outer lip has a tooth. I think it may be safely relegated to Phyllonotus, Swains. *M. umbrifer*, Conr. (xliii, 11). Miocene; Virginia.

UROSALPINX, Stimpson.

Syn.—Adamsia, Dunker. Agnewia, T.-Woods.

Distr.—20 recent species. Atlantic Coast of America, Cape Horn, Cape of Good Hope, New Zealand, etc. *U. Floridana*, Conr. (xliii, 12).

Fusiform. No proper varices, which are replaced by longitudinal ribs.

Shell elongated oval, or short fusiform, longitudinally ribbed or undulated and spirally striated; aperture with a short canal; outer lip dentate and lirate within. Operculum somewhat like that of Purpura, semicordate, with the nucleus at the outer edge a little below the middle. Lingual dentition nearly like that of Trophon.

It differs from Trophon in its operculum, and from Ocinebra in its smoother shell, want of distinct varices, and open canal.

Urosalpinx cinerea occurs upon the Atlantic coast of the United States from Maine to Florida. The animal is small, foot scarcely covering the aperture, very little dilated at the front angles, cream-colored, margined with lemon-color beneath, punctured with light drab above; siphon merely surpassing the tip of the canal; head scarcely protruded; tentacula nearly united at origin; eyes black, at the outer upper third of tentacula, which third is a mere filament, contractile. Motions sluggish. Littoral. The eggs are contained in small transparent membranous parchment-like vases, each of which is attached by an expanded foot to some solid substance, usually the under surface of an overhanging rock, a little above low-tide mark. Each female deposits from ten or twelve to more than a hundred of

these vases, the process of laying occupying several weeks. The vases are generally attached in more or less regular rows, covering sometimes an area of three or four square inches. In shape and size they are like the egg-cases of Purpura, but without the slight reddish tinge of the latter. They are flattened vertically, and their edges are marked by keel-like ridges. Unlike the vases of Purpura, each of which contains several hundred eggs, those of Urosalpinx contain only from six to twenty, ten or twelve being the usual number.

SCALASPIRA, Conrad, is certainly closely allied to, if not identical with Urosalpinx; if the latter, it has priority: it would scarcely be advisable, however, to reject Stimpson's well-characterized genus in favor of one having no diagnosis, and only known by its type. *Scalaspira strumosa*, Conr. Miocene; Virginia.

EUPLEURA, H. and A. Adams.

Distr.—5 sp. Atlantic Coast of United States, West Indies, Panama. *E. caudata*, Say (xliii, 13).

Ranelliform, with a pair of lateral varices, one on either side, and intermediate smaller varices; aperture dentate within.

The lingual dentition differs entirely from that of Ranella, and resembles Murex: the shell also resembles some of the small Murices, and particularly Urosalpinx. The geographical distribution of the group is entirely different from that of Ranella.

TYPHIS, Montfort.

Etym.—*Typhos*, smoke.

Distr.—15 recent species. Mediterranean, Cape, Ind. Ocean, Tropical America. *T. tetrapterus*, Bronn (xliii, 14). Fossil, 8 sp. Eocene—; London, Paris.

Ovate or oblong, with projecting hollow tubes between the three spinose varices; aperture suborbicular, prolonged in front into a closed siphonal canal.

The ascending tube which is the distinguishing feature of the shells of this genus is occupied by an extension of the mantle-margin of the animal.

The operculum is ovate, with apical nucleus, like that of Murex.

TROPHON, Montfort.

Etym.—*Trophonius*, a mythological deity.

Distr.—40 species. Mostly cold seas; typically Arctic and Antarctic. *T. clathratus*, Linn. (xliii, 15). Fossil; Chili, California, England, etc.

Varices numerous, lamelliform or laciniated; spire prominent; aperture ovate; canal open, usually turned to the left; shell white, often dark-colored within the aperture.

The typical Trophon has a fusiform shell, thin and white, the whorls with numerous, sharp, laminated varices, the interstices smooth, or spirally ribbed; canal open, usually turned to the left; no umbilicus; lip thin, smooth within. This group is essentially boreal in distribution. There is, however, another group of species inhabiting the southern temperate and Antarctic zones, which, whilst possessing the main features of the type, the laminæ and the white color, present peculiar characters. These shells are usually broadly ovate, shouldered, umbilicate, the aperture dark-colored within. They form a transition to Siphonalia, and might with almost equal propriety be included in that genus. Montfort's definition of the genus Trophon, indeed, does not correspond so well with the typical group as now recognized, as it does with these Siphonalia-like shells.

SUBFAMILY *PURPURINÆ*.

The Muricidæ naturally subdivide into two groups, one of them (Murices) distinguished by varices on the shell, operculum with terminal initial point, whilst the other (Purpuræ) has nodules but no varices, patulous columella, short canal or mere basal notch, operculum with lateral nucleus; yet on the confines of these two groups occur forms which partake of the characters of either, and the classification of which is entirely arbitrary. Ocinebra, species of Trophon, Urosalpinx and Eupleura have undoubted relationships with Purpura, yet are classed with Murex—partly because the species have usually been considered or were described as Murices; on the other hand, *Purpura crispata* and its allies possess the variceal features of Murex. Kobelt has, on this account, included them in his catalogue of the genus Murex; but on account of the extreme variability of the species (some specimens being without varices) and the number of connecting forms between the smoother varieties and typical Purpuræ, I prefer to retain them in the group to which they have usually been referred.

If the difficulty of defining these two subfamilies is great, still greater does it become when we descend to the genera and subgenera of either of them. Various authors have attempted it, from the "groups" of Kiener's monograph to the genera and subgenera of H. and A. Adams. I adopt the latter as a mere convenience, premising that nature presents her specific forms here (as frequently elsewhere) in such continuous series, that no real line of demarcation can be traced; the characters selected represent simply the high tide of an osculation, which at its ebb merges into the next incoming wave.

PURPURA, Bruguiere.

Syn.—Mancinella, Link. Microstoma, Swn. Thais, Link.

Distr.—57 sp. All parts of the world, low water to 25 fathoms. *P. Persica*, Linn. (xliv, 16). Fossil, 40 sp. Tertiary—.

Shell oblong-oval, last whorl large; spire generally short; aperture ovate, large, terminating in a very short, oblique channel, or notched; columella flattened; outer lip simple.

The animal does not differ essentially from that of Murex in its general external and anatomical characters. The eyes are usually placed near the tips of the tentacles, the siphon is short, and the foot not large.

This is one of the genera from which the ancients obtained dyes; by pressing on the operculum of *P. lapillus* (xliv, 22), a fluid will be obtained which colors a dull crimson. The metropolis of this form is Northern Europe; the North American specimens, as well as those from Southern Europe and North Africa, being stunted in comparison of size and ornamentation. Its fossil distribution ascends as far back as the Red Crag of England. It lives gregarious on rocks and stones within the tides, where it preys on mussels, limpets, and barnacles. It is especially fond of oysters, and is considered a destructive enemy by the cultivators of the bivalve. A single reversed, as well as a scalaroid specimen are recorded by Mr. Gwyn Jeffreys. He says that "this mollusk has a shambling gait and sedentary habits, and seems to be always eating or digesting its food. Lister, however, observed it early in the morning, at the commencement of June, otherwise engaged, viz., in perpetuating its species on a dry rock after the tide had receded. It is very destructive to mussel-beds, and is said by Linné to eat the dead fish left in fishermen's nets. I have seen it busily feeding on *Balanus balanoïdes*, its strong proboscis being inserted between the opercular walls of the barnacle. According to Mr. Osler, it also devours Littorinæ, Trochi, Naticæ, and even its own kind. From what I have observed of the mode by which it perforates the shell of a mussel, I am inclined to agree with Mr. A. Hancock, that it uses its tongue. I cut off the end of the proboscis of a Purpura while it was attacking a mussel; the part thus lopped still remains in the hole, with the front of the tongue exposed. The hole is shaped like an inverted cone, and exhibits under the microscope extremely fine scratch-like striæ, as if caused by the rasping action of the lingual apparatus. I believe the movement to be rotatory, because the sides of the hole are quite even. The process is an extremely slow one. Mr. Osler states that, after watching for some hours a Purpura attached to a Limpet, he found the perforation incomplete; and Mr. Spence Bate and Mr. Bretherton noticed that it took two days to get through the shell of a moderate-sized mussel. It does not appear that the prey is destroyed by any poisonous secretion of the whelk, after it has gained access to the interior. The proboscis is at

tricose; aperture wide; columella arcuated; inner lip excavated, corrugated at the fore-part. *P. planospira*, Lam. (xliv, 18).

THALESSA, H. and A. Adams. Spire elevated, whorls spinose, angulated at the upper part; aperture moderate; columella rounded, tubercular in front; outer lip nodulous internally. *P. hippocastaneum*, Lam. (xliv, 19).

STRAMONITA, Schum. Spire elevated, whorls simple or nodulous; aperture moderate, produced anteriorly; columella rounded, simple in front. *P. Floridana*, Conr. (xliv, 20).

TROCHIA, Swains. Whorls separated by a deep groove; inner lip thickened, convex, striated; aperture with a very short canal. *P. cingulata*, Lam. (xliv, 21).

POLYTROPA, Swains. Spire acuminate, whorls foliated or tuberculose; inner lip flattened; canal small, oblique; aperture narrowed at the fore-part. *P. lapillus*, Linn. (xliv, 22).

CRONIA, H. and A. Adams. Shell ovate; spire acuminated; aperture moderate; inner lip callous at the upper part; columella straight, simple anteriorly. *P. amygdala*, Kiener (xliv, 23).

PURPURELLA, Bellardi, 1882. Aperture with a posterior canal, defined by callous margins. *P. canaliculata*, Bellardi. Tertiary; Northern Italy.

TAURASIA, Bellardi, 1882. Aperture canaliculate posteriorly, with callous margins; columella with an anterior plication. *P. subfusiformis*, d'Orb., and two other species. Tertiary; Northern Italy. Neither this nor the preceding group possesses characters of much importance.

[SINUSIGERA, d'Orb.

Syn.—Cheletropis, Forbes.

Examples.—*S. cancellata*, d'Orb. (xx, 47). *S. Huxleyi*, Forbes (lxxxvii, 13).

Turbinate, imperforate, dextral or sinistral, with a smooth, striate or tuberculate surface and frequently, a keeled periphery; aperture channeled in front, peristome thickened, reflected, with one or two claw-like lobes.

The animal has four arms, arranged in cruciform manner and used for swimming. There are two tentacles, and the eyes, well-formed, are situated on the outer side of their bases. Respiratory siphon short, being a simple fold of the mantle. Foot large and very mobile, furnished with a small, thin spiral operculum; unprovided with a float. The dentition (xx, 48) has been supposed similar to that of the Muricidæ—and the species have, consequently, been referred, as larval forms to that group.

Dr. Jousseaume has established the identity of a species of Sinusigera with *Purpura hæmastoma*, of which it is the larval form—his series of specimens of various ages, collected at Benguela, on the West Coast of Africa, showing a gradual develop-

ment of the adult character. The young Purpura shells retain the embryonic Sinusigera at the summit of the spire for a considerable period, but it is eventually lost by erosion. That all the species which have been referred to Sinusigera are larval forms of various species of Purpura does not follow, from this observation; some of the related genera may be involved Mr. Arthur Adams has identified another species of Sinusigera with *Purpura biserialis*, and Mr. Craven thinks that his *S. perversa* is the young of a Triforis or of some allied genus in Cerithiidæ.

Sinusigera is pelagic, and is encountered in mid-ocean, in tropical seas having feeble currents and where calms prevail.

Mr. Craven, who has recently monographed the genus, enumerates twenty species.]

Purpuroidea, Lycett.

Distr.—*P. nodulata*, Lycett (xliv, 24). Oolite, England.

Shell turriculated, ventricose; summit of the spire sharp; whorls convex, with a line of spines or tubercles on the shoulder; columella smooth, rounded, excavated in front; siphonal notch wide, no groove at the posterior junction of lip and columella; outer lip thin. Fossil.

This fossil genus has been confounded with Purpurina, d'Orb.: its typical forms appear to be close to Purpura, and the species I figure has some resemblance to the recent *P. chocolatum;* whereas Purpurina is nearly related, apparently, to Cancellaria. The distinctive character from Purpura consists in the close junction of lip and columella posteriorly.

Lysis, Gabb.

Distr.—*L. duplicosta*, Gabb (xliv, 25, 26). Cretaceous, California.

Stomatiform, very oblique; spire moderate; whorls costate; aperture narrow, outer lip simple, inner lip straight, concavely expanded over the wide umbilicus so as to completely cover it.

Supposed by Gabb to be nearly related to Stomatia; I have examined authentic specimens, and do not hesitate to refer it to the Purpuræ.

Iopas, H. and A. Adams.

Distr.—*I. sertum*, Brug. (xlv, 40). Polynesia.

Shell ovate, rugose, last whorl large; spire acuminate; aperture moderate, emarginate and channeled in front; columellar lip covered with a thin enamel, and with a prominent plait-like callosity at the hind-part; outer lip sinuous, crenate within.

Vexilla, Swainson.

Distr.—4 sp. Japan, Philippines, Polynesia. *V. vexillum*, Chemn. (xliv, 27).

Shell purpuriform; inner lip flattened and depressed, but outer lip, when adult, thickened, inflected and toothed; aperture wide.

USILLA, H. Adams. Founded on *V. fusco-nigra*, Pease, which differs from the typical Vexilla in the spire being acuminate, and the aperture somewhat contracted or narrowed.

Pease (*Am. Jour. Conch.*, iv, 115) adopts the subgenus, and adds to it *Purpura leucostoma*, Desh., and *Planaxis cingulata*, Gould. I very much doubt whether the group will stand, as the little specimen of Pease's species before me is very suggestive of Pisania, and Deshayes' species is a true Purpura, and evidently very closely allied to, and as I believe = *P. columellaris*. The opercula of Pease's and Gould's species are unfortunately undescribed.

RICINULA, Lam.

Etym.—Diminutive of *ricinus*, the (fruit of the) castor-oil plant.

Syn.—Canrena, Link. Drupa, Bolt. Pentadactylus, Klein.

Distr.—*R. horrida*, Lam. (xliv, 28, 29). 30 sp. India, China, Philippines, Australia, Pacific, Panama, Red Sea, Natal, West Indies, Brazil. 3 fossil sp. Miocene—; France.

Shell ovate, solid; spire short, whorls tubercular or spinous; aperture linear, narrow, contracted by callous projections, with a short, oblique, emarginate canal in front; inner lip tubercularly wrinkled; outer lip internally with plait-like teeth, often digitate.

SISTRUM, Montfort. (Morula, Montf.) Has usually a longer spire, the shell is smaller, more fusiform, the teeth within the outer lip not grouped, but single. This separation has its conveniences: nevertheless the characters, as in so many other groups, only serve well for the recognition of some of the forms; others must be arbitrarily placed. The dividing line between Sistrum and Engina, Latirus and some Pisanoid species is very difficult to trace. The group is essentially Polynesian in distribution, frequenting coral reefs. *R. morus*, Lam. (xliv, 30).

MONOCEROS, Lam.

Etym.—*Monos*, one, *ceras*, a horn.

Syn.—Acanthina, Fischer. Rudolpha, Schum. Unicornus, Montf.

Distr.—10 sp. California to Chili. Tertiary of Chili. *M. giganteum*, Lesson (xlv, 41). *M. lugubre*, Sowb. (xlv, 42).

Shell ovate, last whorl large; spire rather elevated; aperture semilunar; inner lip wide and flattened; outer lip crenated, with a prominent tooth at the fore-part.

PSEUDOLIVA, Swainson.

Etym.—Resembling *Oliva*.

Syn.—Sulcobuccinum, d'Orb. Gastridium, Gray. Buccinorbis, Conr. Pseudodactylus, Herm.

Distr.—6 sp. E. Africa. *P. plumbea*, Chemn. (xlv, 43). Fossil. Eocene of America and Europe.

Shell ovate, solid, subglobose; spire very short, suture slightly channeled, whorls tumid round the upper part; aperture oval, canal very short; inner lip arcuated, with a callosity at the hind-part; outer lip thin, furnished at the fore-part with a small tooth or callosity.

The shell has some resemblance to Monoceros in its tooth on the outer lip, and its operculum is purpuroid; it also resembles the Olivancillariæ. The animal is unknown. H. and A. Adams described a subgenus Macron, in which are included several species from the West Coast of America, but this group must be eliminated, as the operculum has since been ascertained to be unguiculate. *P. Australis* is now placed among the Eburnæ as subgenus Zemira.

CHORUS, Gray.

Distr.—*C. Belcheri*, Hinds (xlv, 43, 44). Japan, California.

Shell laminately varicose, spinose on the shoulder; canal rather long; outer lip with a spine as in Monoceros.

To this group have been referred *Ch. monoceros*, *Desh.* (= *Monoc. giganteum*, Lesson), *Ch. xanthostoma*, Brod. (= Trophon), and *Ch. Belcheri*, Hinds. These three species are certainly representatives of three distinct genera, of which the last only remains to represent this genus. The dentition of *Ch. Belcheri* reminds one of the Buccinidæ more than any other group, and is nearest to that of the subfamily Photinæ; but the shell does not bear out this relationship, its spines, peculiar varices and long canal suggesting Trophon, from which it is distinguished by having a purpuroid operculum and the tooth of a Monoceros. A naturalist fond of making systematic groups might construct for this species a family, to follow, perhaps, Ptychatractidæ and intervening between the latter and Buccinidæ. In placing it between Monoceros and Pseudoliva and Rapana, I think that I have adopted the best alternative to the course above suggested.

PINAXIA, A. Adams.

Distr.—*P. coronata*, A. Ad. (xliv, 31). Polynesia.

Shell conical; spire short, acute; aperture oval-oblong, emarginate anteriorly; inner lip flattened, with several transverse plaits in the middle; outer lip acute, grooved internally.

The shell has some resemblance to *Pyrula pugilina* in form as well as in the revolving raised lines within the aperture, but differs in possessing plications upon the columella. Mr. E. A. Smith has, fortunately, received specimens with the operculum in situ; this is purpuroid, and definitely settles the proper place of the genus. The animal is unknown, and a description of it,

and its dentition particularly, is desirable. The plications of the columella only appear upon old specimens, and the tubercles of the shoulder of the body-whorl are not always developed.

CONCHOLEPAS, Lam.

Syn.—Conchopatella, Chemn.

Distr.—*C. Peruviana*, Lam. (xlv, 45). West Coast of South America.

Shell ovate, last whorl very large, expanded; spire very short, obliquely inclined towards the left side; aperture very wide, slightly channeled anteriorly; inner lip flattened; outer lip with two small teeth in front.

The single species has the basal groove of Monoceros and Pseudoliva, but its margins are defined by two sulci, giving rise to two horns, instead of one, on the edge of the outer lip. The immense development of the last whorl gives the shell a somewhat limpet-like rather than a spiral appearance. In consequence of this great enlargement of the aperture the operculum, which is purpuroid in its growth, is entirely unfitted to close the aperture, and, in fact, becomes a useless appendage. The shell is used by the Magellanic tribes as a drinking-cup, and by the Chilians the foot is eaten, being well-beaten to render it tender. Large piles of shells around the cabins of the fishermen testify their appreciation of this mollusk as an article of food. The large foot, like that of the limpets, adheres by suction to rocks, and so tightly that the shell is detached from them with extreme difficulty, unless suddenly removed before the animal becomes aware of danger.

Mr. A. Adams formed a subgenus Coralliobia for *Conch. fimbriatus* described by him in 1852; subsequently this subgenus and its type were ranged under Leptoconchus in H. and A. Adams' "Genera." This latter disposition I consider correct.

CUMA, Humph.

Syn.—Cymia, Mörch.

Distr.—9 sp. Panama, Indian Ocean, China, West Coast of Africa. *C. Kiosquiformis*, Duclos (xliv, 32).

Shell pyriform; spire elevated, acute, whorls angular or spinose; aperture oval-oblong; columella convex, sometimes with a strong angular tubercle in the middle; outer lip acute, grooved internally.

This small group is related by some of its species to Rapana; by others, to Rhizochilus.

The genus Cuma of Humphrey is founded upon a number of species, of which about one-half have been identified and referred to other genera, and no species remains which can be certainly made to represent the group. Mörch, inasmuch as Milne-

Edwards has used the name in Crustacea, in 1828, proposed Cymia for these shells. I am not disposed to disturb a well-known name, even under these mitigating circumstances; besides, it is not impossible that Milne-Edwards' genus may itself be superseded by some other name or dismembered, and nothing left of it, as in our old genus *Pyrula*.

Humphrey may not have understood what limit he ought to have given to his genus Cuma, and whilst I do not think that he has any very strong claim on us for the recognition of any of his names, I am unwilling to increase the already confused state of our nomenclature by attempting to follow out the absurd and impracticable "rule" of the British Association. Every naturalist knows that the names of genera in his specialty are repeated in other branches of natural science, and accepted without hesitation, and that we only follow the "rule" by changing a duplicated name occasionally. Besides, no one pretends to be a general naturalist in these days, and the conchologist will not find himself embarrassed by the use of the generic name Cuma in any other subkingdom of nature, or in all of them, whilst he would be "very considerably bothered" upon encountering the name Cymia.

RAPANA, Schum., 1817.

Syn.—Ecphora, Conr. Stenomphalus, Sandb.

Distr.—8 sp. China, Japan, Philippines, Australia. *R. bezoar*, Linn. (xlv, 46).

Shell ventricose, axis perforated to the apex; spire depressed; aperture oval, narrowed anteriorly; canal open, slightly recurved; inner lip reflected, free anteriorly; umbilicus wide, corrugated.

This well-characterized group includes a few species usually found upon coral reefs in tropical seas, and probably living upon the coral polyps.

Fusus quadricostatus of Say (xlv, 47), a common American tertiary fossil and very remarkable shell, is referable to this genus: Conrad has formed for it his genus Ecphora.

LATIAXIS, Swainson. Whorls more or less detached, carinated; aperture small, trigonal; canal narrow, rather long, curved. The animal and operculum are unknown. *R. Mawæ*, Gray (xlv, 48).

[PSEUDOMUREX, Monterosato.]

An aberrant form, referred by authors to Murex, to Coralliophila and to Latiaxis. I cannot find any good characters by which to separate it from Coralliophila. It includes four species and numerous varieties, all inhabiting the Mediterranean Sea. *P. bracteatus*, Brocchi.

RHIZOCHILUS, Steenstrup.

Distr.—22 sp. Coral Reefs, Pacific, West Indies.

Shell when young free, resembling Rapana; when adult, sometimes with more or less irregular solid shelly extensions of the outer and inner lips, which clasp the axis of coral or the surface of neighboring shells, and at length close the mouth with the exception of the anterior siphonal canal which is converted into a shelly tube. No operculum (?).

We do not know how many of the species allied to the type of the genus may partake of this singular mode of growth; it has only been observed in *R. antipathicus* (xliv, 33, 34). A large number of species have been grouped by Messrs. H. and A. Adams in a subgenus *Coralliophila*, the character of which is, that they do not (are not known to) form this shelly enclosure. If this supposed difference of habit should be proved by observation, there can be no doubt that the two groups should be generically separated. It may be remarked that no lingual denticles have been found in the animals of Coralliophila, Leptoconchus or Magilus examined by Troschel. Coralliophila possesses an operculum; I do not know whether the younger stage of Rhizochilus has one or not, but the presumption is that it has not.

CORALLIOPHILA, H. and A. Ad. (See remarks above.) A large number of specific forms have been described, many of which have not been figured. Judging from the extreme variability of the well-known species both in form and sculpture, it may be anticipated that most of the more recently characterized species will prove to be synonyms. *R. neritoidea* (xlv, 49).

GALEROPSIS, Hupé. I venture to place under this name the *Rhizochilus madreporarum*, Sowb. (xliv, 35), which possesses differential characters from both Rhizochilus and Coralliophila. The young shell is free, and not unlike a Coralliophila, and in this stage it has a small, thin operculum with lateral nucleus. The animal has a short siphon which scarcely projects beyond the canal. It is sluggish in its movements. As it matures it becomes attached to the coral, on which it lies and adheres with great tenacity, often allowing the foot to be torn away before releasing its hold. The conformation of the lip corresponds exactly with the irregularities of the place of adhesion. Upon removing the animal, scars will be noticed on the coral, more or less worn by the abrasion of the shell, and old specimens will be found to have deposited a shelly base. When removed, the animal is very timid and never wholly expands. It can only partly withdraw behind the columella-shelf, leaving a portion of the mantle and foot exposed. The foot is small, of an oval form, thick and fleshy. The tentacles rapidly taper to a fine point, on which the eyes are sessile a little beyond the middle of their length. The foot is tinged with pale orange, dotted with white along the upper margins. The mantle is colorless centrally,

tinged with orange along the margins and dotted with white, the dots crowded anteriorly and becoming more and more remote posteriorly. The operculum is of a pinkish violet color. The foot has a well-developed duplication in front. Such is the description given by Mr. W. H. Pease, who places the species in Rhizochilus proper; but it appears to me to differ from that genus in the excavated, shelf-like columella, the expanded continuous lip of the adult (very like Concholepas) and in not closing up its aperture with shelly matter when mature. In the expanded lip, flattened columella and tooth-like projection of the basal margin of the latter it well agrees with Hupé's genus Galeropsis, a tertiary fossil.

SEPARATISTA, Gray.

Syn.—Lippistes, Montf.

Distr.—4 sp. Cape, Philippines, Polynesia. *S. Chemnitzii*, A. Ad. (xliv, 36).

Shell turbinate, subdiscoidal, the first whorls contiguous, the last more or less separated; aperture expanded, slightly angulated, the margin everted; umbilicus very wide, infundibuliform with the whorls visible to the apex. No operculum.

The animal is unknown, and the relationships of the genus are doubtful.

MELAPIUM, H. and A. Adams.

Distr.—1 sp. East Indies.

Shell ovate-pyriform, ventricose, imperforate, porcellanous; spire very short, apex papillary; aperture expanded, inner lip with a thick, smooth callus at the hind-part, columella twisted anteriorly, with a prominent oblique plait; canal wide, recurved, directed towards the left. Operculum unknown.

This genus was instituted for the *Pyrula lineata* of Lam. (xlv, 50); the animal and operculum of which are unknown. Its systematic position is very doubtful. It has the porcellanous texture of Pusionella; from which, however, it is distinguished by its ventricose body-whorl and short papillary spire.

WHITNEYA, Gabb. This fossil group is said by its author to be related, probably, to Fasciolaria, but I agree with Stoliczka that its nearest apparent ally is Melapium; from which I can only separate it geologically. *M. ficoides*, Gabb. Cretaceous; California.

RAPA, Klein.

Syn.—Bulbus, Humph. Rapella, Swn.

Distr.—2 sp. Indian Ocean to Polynesia. *R. papyracea*, Lam. (xlv, 51).

Shell thin, globosely pyriform; axis perforate; umbilicus partly concealed by the reflected inner lip; spire obtuse; aper-

ture oblong, produced anteriorly into a wide, subrecurved canal. Operculum unknown.

This, like the preceding genus, has only one properly authenticated species; and that is unquestionably very closely related to Leptoconchus. The operculum is of the normal purpuroid type, but like the shell, very thin, translucent and yellowish white.

MAGILUS, Montfort.

Syn.—Campulotus, Guett. (part). Tubulites, Davilla. Leptoconchus, Ruppell.

Distr.—5 sp. Coral Reefs, Mauritius, Red Sea. *M. antiquus*, Lam. (xlv, 52, 53).

Shell when young, spiral, thin; when adult, white, solid, tubular, spiral for three or four whorls, the last prolonged into an irregular straight or flexuous tube, solid posteriorly, and with a siphonal keel on the left side. Operculum ovate, nucleus sublateral.

In the "Genera of Recent Mollusca," the authors, following Ruppell, distinguish the species of Leptoconchus from the single species of Magilus. They thus describe the animal of the former:

The mantle-margin is greatly thickened and fleshy; the tentacles are small, broad and united at their bases; the eyes are small and black, on the outer side of the tentacles, near their tips; the foot is small, short, obtuse and rounded behind, with a thin, expanded, disk-like lobe in front, and the siphon is obsolete. The genus differs from Campulotus (Magilus) not only in the absence of the operculum, but in the shell never forming a long tubular projection of the mouth as in that genus. It comprises but few species, which take up their abode in corals and madrepores.

Deshayes, in his "Conchology of the Island of Bourbon," 1862, describes a number of species of Leptoconchus as well as the anatomy of one of them, confirms the non-existence of the operculum and sustains the separation from Magilus.

On the other hand, that experienced conchologist, Mr. G. B. Sowerby, in his introductory remarks upon the genus Magilus, in Conch. Iconica, xviii, 1872, unites Leptoconchus with that genus. He says:

"The habits of this genus are very curious. The young fry, after a short period of free locomotion, seems to find its way into some hole in a growing madrepore, and then to become stationary; but as the substance grows around it, it would soon become enclosed unless the growth of the shell kept pace with that of the madrepore. In order, therefore, to keep its aperture close to the surface, the two lips are extended in the same direction in the form of an irregular tube. The Magilus leaves its

shell in the original cavity, and filling it up (with shelly material) so that it becomes solid, occupies only that portion of the tube which is nearest to the opening. The walls of the tube are thickened, and the portion which represents the canal is consolidated into a thick keel. The species which have not been found as yet in an advanced state, and which appear generically to resemble the young shells of *Magilus antiquus*, have been separated by authors under the generic term Leptoconchus; and it is asserted that while the Magilus possesses an operculum, the Leptoconchi do not. It is also said that the young shell of the Magilus begins to form a thickened and entire edge to its aperture, as if preparing for the future erratic course of its shell. It appears to me, however, that it depends upon the accidental conditions of habitat and growth whether and at what period of life the shell of a Magilus shall become tubular; and as for the operculum, it is certain that some, if not all, the species enumerated as Leptoconchus by authors have been found with opercula; notably, *L. Lamarckii*, Desh. The Isle of Bourbon, the Mauritius and Sandwich Islands—perhaps most islands with reefs—afford homes to the Magili."

We agree with Mr. Sowerby; indeed, it would be impossible to designate from the shells which species should be referred to Leptoconchus and which ones to the juvenile condition of Magilus. It is probable that the development of the tube is accidental, and it is equally probable that, as in Conus, the operculum is not always developed. Troschel has not discovered any indication of armature upon the lingual ribbon. So irregular are the shells of the Magili, and so much is their growth influenced by the circumstances of their habitation, that all the species that have been differentiated from *M. antiquus* must be regarded with suspicion. When numbers of specimens, from different localities, and collected with a view to coalescence rather than to differentiation, shall have been compared, we shall be able to assign definite places to the species which we are now compelled to take on probation.

Magilina, Vélain.

Distr.—*M. serpuliformis*, Vélain (xliv, 37, 38). Indian Ocean.

Young shell free, formed of a single whorl; finally prolonged into a tube which is attached by one side to the surface of submarine bodies.

The species which forms the type of this genus is much smaller than those of Magilus. The distinctive characters consist in the spiral shell having one whorl only and in the fixed adult being attached by one side of the tube to the external surface of submarine objects, instead of growing in their interior. This is a great change of habit, and the animal may prove to have no rela-

tionships with Magilus but rather with Vermetidæ. I do not know how closely it may be related to Nisea.

NISEA, Marcel de Serres.

Distr.—*N. simplex*, Serres (xliv, 39).

Shell composed of a discoidal portion and of two tubes; the last whorl recurved upon itself in the same way as Anostoma, in two tubes of variable length and less sinuous than the single tube of Magilus. (Fossil.) Relationships very doubtful.

FAMILY TRITONIDÆ.

Shell with varices, which are either few and irregularly disposed (Triton) or form a continuous row crossing the whorls on opposite sides (Ranella). The number of varices does not exceed two to each whorl, whilst in Murex the smallest number is three. Operculum annular, with subapical or central nucleus. Mantle enclosed, siphon straight, foot small. Lingual membrane with teeth in seven rows (3·1·3), like the Doliidæ, etc. (The Muricidæ have the teeth 1·1·1.) The dentition is illustrated on Plate xi, fig. 33.

Conchological reasons mainly induce me to place the Tritonidæ in close connection with the Muricidæ, rather than arrange them with the Cassididæ and Doliidæ, as indicated by their dentition.

The Tritonidæ first positively appeared in the eocene strata; the genus Spinigera, d'Orb., from the cretaceous, being now referred, more correctly I think, to the family Strombidæ, and Trachytriton, Meek, also cretaceous, does not belong certainly to the family.

TRITON, Montf.

Etym.—*Triton*, a sea-deity.

Syn.—Tritonium, Link. Charonia, Gistel. Aquilus, Montf. Cabestana, Bolt. Lampusia, Schum. Ranularia, Schum. Colubraria, Schum. Linatella, Gray. Lotorium, Montf.

Distr.—105 sp. Tropical seas, world-wide; low water to fifty fathoms. Fossil, 80 sp. Eocene—; Europe, Chili, etc. *T. variegatus*, Lam. (xlvi, 54).

Shell oblong; spire prominent, whorls with a few remote and non-continuous varices; columella rough or smooth; canal recurved, short or long; outer lip internally crenated or denticulated.

Operculum ovate, its growth annular either from a subapical or submarginal nucleus.

Whilst the lingual armature of Triton allies it closely with Dolium, etc., among the so-called tænioglossate mollusks, the affinities of the animal are on the whole closer, and those of the shell decidedly so, to Muricidæ. It may be considered a con-

necting link between the two groups, but certainly cannot be safely removed from the vicinity of the latter, to which it is not only allied by its operculum (which is entirely different from that of Dolium), but so closely by the shell in some instances, that the assignment of the generic position is quite arbitrary.

The Tritons are distinctly tropical in distribution, no species inhabiting the colder seas. The species are numerous and beautiful, presenting a great range of variation in size and color; one species being almost the largest of gastropod mollusks, attaining a length of one and one-half feet, whilst others, belonging to the Epidromoid section, do not exceed one-half inch in length. The cancellated forms are chiefly East Indian, and are dredged in sand in deep water; the West Coast of America species, covered with a rough epidermis, are obtained in sandy mud at from six to thirty fathoms depth. A number of species have a world-wide distribution, which is doubtless due to their free-swimming or pelagic larvæ. These, unlike the Murices, but like the Purpuræ, are very different at first from the adult both in animal and shell, undergoing a metamorphosis at a period subsequent to hatching.

I adopt the well-known name Triton in preference to the previously given Tritonium of Cuvier, believing that the interests of science are best conserved by keeping the nomenclature as stable as possible. Triton has been used in other departments of zoology, but so have many other generic names, which are nevertheless accepted without question.

Reeve says: "The Tritons are shells of much more solid structure than the Murices or Ranellæ, and of much more simple growth. They are not furnished with any spines nor have they any ramified branches like the Murices; the rude manner in which the whorls are convoluted seems rather to indicate that their animal inhabitant, though possessing abundant power of calcification, is of somewhat sluggish growth. The epidermis of Triton is often remarkably thick, hairy and bristly, and is sometimes accompanied with small tufts of bristles. Another curious peculiarity in these shells is the structure of the apex; it appears in numerous instances to be formed of horny substance, thinly plated with shelly matter, and it is not an uncommon thing to find examples in which the calcareous plating is worn off so as to expose the horny cast underneath. The columella of the Tritons is generally covered with a bright coat of wrinkled enamel, and the outer lip becomes thickened in a manner exceedingly curious; upon arriving at maturity the lip curls under so as to form a deep, broad channel or gutter, and this is then filled up to form the thickened lip. The varices are all constructed in the same manner, each forming for a time the margin of the aperture; they are destined, it is conjectured, to

protect the lip during a season of rest, and it would be extremely interesting if it could be discovered what length of time ordinarily elapses between the formation or deposit of the varix and the renewal of the operation of growth."—*Conch. Icon.*, vol. ii, Triton, 1844.

Mr. Arthur Adams mentions the adaptation of the Trumpet-shell (*T. tritonis*) to the purposes of a tea-kettle by the inhabitants of the Typinsan archipelago, near the Loo-Choo Islands; the operculum forming the lid, the canal answering the purpose of a spout, and the shell suspended by a wooden hook over the fire. Mr. Adams says that this rude vessel was adopted several times for the convenience of his party, and answered its purpose admirably.—*Narrative Voy. Samarang*, i, 89.

Madame Power found *T. nodiferus* capable of reproducing amputated tentacles, etc. The Silicians and Algerians eat this mollusk and esteem it a delicacy. At Nice, the fishermen and country people make a hole in the apex of the spire and use the shell as a trumpet which, Vérany remarks, produces a braying sound. It is an indispensable instrument in the old-fashioned charivari, which he describes as a deafening serenade to signalize the marriages of ill-assorted or unpopular couples.

The species of Triton being numerous, several attempts have been made to separate them into generic or subgeneric groups; the most successful being the arrangement of Messrs. H. and A. Adams. Two of these groups, however, Simpulum and Cabestana, are so closely related that I think Kobelt has very judiciously united them. Priene is the connecting form approximating Triton and Ranella; whilst in the latter genus species of the group Lampas recall Triton.

SIMPULUM, Klein. Shell fusiform, whorls nodosely ribbed; outer lip thick, plicate-dentate internally. Operculum with apical nucleus. *T. chlorostomus*, Lam. (xlvi, 55).

CYMATIUM, Bolten. Whorls triangular; aperture longer than the spire; outer lip dentated internally. Operculum with apical nucleus. *T. tigrinus*, Brod. (xlvi, 56).

GUTTURNIUM, Klein. Shell pyriform, subturreted, canal long, narrow. Operculum with submarginal initial point, near the middle of the inner margin. *T. cynocephalus*, Lam. (xlvi, 57).

The shells of this group possess a peculiar polished, porcellanous outer and inner lip, the latter reflected over the columella, together with a short, rounded pyriform body and lengthened, narrow, more or less twisted canal.

EPIDROMUS, Klein. Shell with long, generally curved spire; aperture small and canal very short. Operculum triangular, with submarginal nucleus. *T. distortus*, Schub. Wagn. (xlvi, 58).

PRIENE, H. and A. Ad. Shell ventricose, thin, cancellated or plicated; canal short. Operculum with apical initial point.

W. Coast So. America, northwards to Alaska; Japan. *T. scaber*, King (xlvi, 59).

This small group contains shells of comparatively large size, thin, cancellate, white without any bands or spots of color, usually more or less covered by an epidermis; the operculum has a terminal initial point. The species inhabit a somewhat limited region, the West Coasts of South and North America, one of them recurring on the Japanese coast. The rarity of varices and general appearance of these shells indicate a passage into the Fusidæ, whilst they appear to connect more remotely with the *argus* group of Ranella and with Buccinum.

The distinctness of the following fossil groups is very doubtful.

RANELLINA, Conrad. The group was never characterized. The type differs from the figure in the varices being partially disconnected, thus showing more affinity to Triton than to Ranella. *T. Maclurii*, Conrad (xlvi, 60). Tertiary; Claiborne, Ala.

PERSONELLA, Conrad. Genus not characterized. Scarcely a Distorsio, but more like a Gutturnium. *T. septemdentatus*, Gabb (xlvi, 61). Eocene; Texas.

TRITONOPSIS, Conrad. The type is a water-worn specimen, which Prof. Angelo Heilprin, who has examined the shell, declares to be too imperfect to assign to it any reliable characters. Has some resemblance to the section Cabestana, like *T. doliarium*, L. *T. subalveatus*, Conrad (xlvi, 62). Eocene; Vicksburg.

TRACHYTRITON, Meek. Its character appears to be confined to the occurrence of *internal* varices, marking the former positions of the lip, and which have not been absorbed when growth recommenced; otherwise very like *Priene Oregonensis* = *cancellatus*. The want of a callus on the upper part of the columella, which Meek makes a distinguishing character from Priene, also characterizes the *P. Oregonensis*, young, as described by Mr. Redfield. *T. vinculum*, Hall and Meek (xlvi, 63). Cretaceous; Dakotah.

DISTORSIO, Bolten.

Syn.—Persona, Montf.

Distr.—3 sp. Red Sea, China, Polynesia, W. Indies, W. Columbia. *D. cancellinus*, Roissy (xlvi, 64).

Shell subturreted; whorls distorted; aperture irregular, contracted, ringent; canal recurved; inner lip dilated, lamellar, rugosely plicated; columella excavated, verrucosely plicate; outer lip sinuous, internally plicate-dentate.

This genus, in its ringent aperture, reminds one of the genus Malea in the Doliidæ.

RANELLA, Lam.

Etym.—*Rana*, a frog.

Syn.—Bufo, Montf. Bufonaria, Schum. Gyrinium, Link. Apollon, Montf. Bursa, Bolten. Semiranella, Gregorio.

Distr.—36 sp. Tropical seas, world-wide. Fossil, 23 sp. Eocene. *R. albivaricosa*, Reeve (xlvi, 65). *R. spinosa*, Lam. (xlvi, 66).

Shell ovate or oblong, compressed, with two rows of continuous varices, one on each side; aperture oval; columella arcuated and ridged, or crenulated; canal short, recurved; outer lip crenated.

The tentacles are commonly somewhat closer together than in Triton, and the head is longer and narrower than in Murex and Fusus; the eyes in some species are nearly basal, but are generally placed about the middle of the tentacles on their outer sides; the siphon is short and directed upwards; the foot larger than in Triton, Murex, or Fusus, and considerably dilated both before and behind; the mantle does not appear to be furnished with fimbriated processes as seen in some Murices. In some species the trunk is enormously developed, whilst in others it is not protruded, in the usual condition of the animal. Operculum ovate, horny, with a lateral nucleus and semicircular elements.

The species are inhabitants of warm seas, and principally tropical: those of the typical group having winged varices live in deep water, whilst the nodose species forming the subgenus Lampas, are found at less depth, and prefer coral reefs and rocks. The animal is active in its movements. Eupleura, formerly considered a subgeneric group of Ranella, is now classed with Muricinæ, partly on account of the lingual dentition of one of its species.

I have retained the generic name Ranella, in preference to Bursa, Gyrinium, Bufo, Rana, etc., all of which have priority, but were obscurely published and have never attained general acceptance.

Mr. Macdonald thus describes the larval state of Ranella:

"I next observed a stout little shell, much resembling a Macgillivrayia in form, but having the spire more minute and sharply marked, and the whorls beset with epidermic spines, disposed in close spiral lines. The microscopic examination of the animal gave unmistakable proof of its being a Ranella, the lingual dentition agreeing, at least generically, with my figures and specimens. On examining the operculum, which in Ranella is so very remarkable, exhibiting three successive stages of growth, I found that it was quite of the same character, only that it had but yet attained the second stage. Finally, on comparing the whole operculum, and the little shell respectively, with the nucleus of the operculum and the apex of the shell of an adult Ranella, I could detect no points of difference, even with magnifying powers; the conclusion, therefore, is irresistible, that

the one is but the young state of the other."—*Linn. Trans.*, xxiii, 69.

Mr. Vélain remarks that *R. proditor* (= *R. argus*) is very plentiful at the Islands of Amsterdam and St. Paul, in the Indian Ocean, where the skeletons of seals, abandoned on the rocks at low-water by the fishermen, were literally covered with lobsters and Ranellæ at the succeeding tide. They are nocturnal in habit and may be readily fished by suspending over-night, in 10 or 15 mètres depth, the body of a bird or fish.

LAMPAS, Schum. (Colubraria, Schum. Crossata, Tutufa and Lampasopsis, Jousseaume.) Shell turreted; whorls nodose; aperture with posterior channel; canal very short and recurved. *R. bufonia*, Gmel. (xlvi, 67).

ASPA, H. and A. Adams. Shell ovate, ventricose, smooth; spire very short; whorls nodulous at the angles; aperture with posterior channel. *R. marginata*, Gmel. (xlvi, 68).

ARGOBUCCINUM, Klein. Spire elevated; canal short; posterior channel wanting. *R. pulchra*, Gray (xlvi, 69).

FAMILY FUSIDÆ.

Shell more or less spindle-shaped, without varices; the lip of the aperture not thickened.

Operculum ovate, acute, with apical nucleus.

The animal possesses the essential features of a Murex.

Dentition (x, 8). That of the typical genus Fusus does not differ essentially from Fasciolaria; Stimpson states (*Am. Jour. Conch.*, i, 54) that it has the saw-like lateral teeth of Fasciolaria, whilst Macdonald (*Ann. Mag. Nat. Hist.*, 4th ser., ii, 243) found another species to possess lateral teeth of the Muricoid type. Troschel finds a Fasciolarioid dentition in *Fusus Syracusanus*, and he has accordingly made for it a new genus, Aptyxis; but Schacko has recently found the same dentition in *Fusus inconstans*, Lischke, a typical Fusus. I think that Macdonald must have mistaken some other genus for Fusus. The dentition of Sipho, which, according to Troschel, resembles that of Fasciolaria, is shown by the more recent investigations of Sars to be Buccinoid. Ptychatractus, with evident resemblance to Fasciolaria, has a peculiar dentition, approaching Murex, and on this character alone Stimpson, followed by Gill, assigns to it a distinct family.

Neptunea, Melongena, etc., long classed with Fusidæ, are now brought into more intimate relationship with Buccinum, and Busycon, and Tudicla will go into the same group; on the other hand Peristernia, Latirus, etc., formerly included in Turbinellidæ, have a Fasciolarioid dentition, which, with added conchological characters, may suffice for their removal from that to the present

family. Stimpson (*Am. Jour. Conch.*, i. 60) describes and figures the dentition of an unknown species of Peristernia from the coast of Georgia, which has the essential features of Busycon, and he thereupon places the genus in Neptuniinæ; but it is evident that he was in error, as Troschel figures known species, which are Fasciolariform in dentition as they are in conchological characters.

Subfamily FUSINÆ. Columella not plicate, not tortuous.

Subfamily FASCIOLARIINÆ. Columella tortuous with oblique plaits or plications.

Subfamily PTYCHATRACTINÆ. Differs from Fasciolariinæ in lingual dentition, and includes only three small boreal species.

Subfamily PERISTERNIINÆ. Columella with transverse plications.

SUBFAMILY *FUSINÆ.*

FUSUS, Lamarck.

Syn.—Aptyxis, Troschel. Colus, Humph. Syrinx, Bolt.

Distr.—65 sp. Tropical and Subtropical, world-wide. *F. Nicobaricus*, Lam. (xlvii, 70). Fossil, 300 sp. Bath oolite (?), Cretaceous to Eocene—.

Shell fusiform; spire long, acuminate, many-whorled; aperture oval, usually striate within; outer lip simple; columella smooth; no umbilicus; canal long and straight. Yellowish brown or light horn-color, sometimes with red-brown strigæ or spots; never banded. Operculum ovate, acute, with apical nucleus.

The genus, as restricted to the spindle-shaped forms, is subtropical in distribution—the northern species usually described as Fusus by the older conchologists being now more correctly referred to the family Buccinidæ.

COLUMBARIA, von Martens. Shoulder of whorls spinose, a revolving ridge on the lower part of body-whorl. Dentition similar to the Pleurotomidæ. *F. Pagoda*, Lesson (xlvii, 71).

SINISTRALIA, H. and A. Ad. Shell reversed, fusiform; canal long; whorls rounded. *F. Maroccensis*, Gmel. (xlvii, 72).

HADRIANA, Bucq. and Dautz. Proposed for the European *F. craticulatus*, Brocchi, which unites the closed canal and varices of Murex with the simple lip and general form of Fusus.

EXILIFUSUS, Gabb. Shell very long, slender, fusiform; spire high; aperture produced into a long, slender, twisted canal.

This group differs from the true genus Fusus, as restricted, by its twisted, slender canal. In this character it approaches some of the Neptuneæ, but its high spire and strongly costate whorls show that it is more nearly allied to the true Fusus. *F. Kerri*, Gabb (xlvii, 73). Cretaceous; N. Carolina.

EXILIA, Conrad. (Exilifusus, Conrad.) Shell very narrow, costate, spire subulate, canal long and narrow. *F. pergracilis*,

Conr. (xlvii, 74). Eocene; Alabama. Scarcely distinct from the typical Fusæ.

TURRISPIRA, Conrad. Has not been characterized, and does not seem to differ from Fusus. *F. Salebrosa*, Conrad (xlvii, 75). Eocene; Alabama.

PRISCOFUSUS, Conrad. Founded on *Fusus geniculus*, Conrad, a very poorly preserved or figured fossil; the type has "been lost for twenty years. The species is wholly unrecognizable, and should be expunged from nomenclature. For this rubbish Mr. Conrad has proposed a genus Priscofusus, but with neither figure nor diagnosis."—DALL, *Proc. Calif. Acad.*, 1877. *F. geniculus*, Conrad (xlvii, 76). Eocene; Astoria, Oregon.

SERRIFUSUS, Meek. Shell short-fusiform; body-volution large, and bi- or tricarinate, with carinæ more or less nodose; spire and canal moderate, the latter bent and more or less twisted; outer lip broadly but slightly sinuous in outline, between the upper carina and the suture. *F. Dakotensis*, Meek and Hayden. Cretaceous; Dakotah.

This form so much resembles the recent *Fusus* (*Hemifusus*) *proboscidiferus*, Lam., that it might well be considered a fossil form of the same group.

JANIA, Bellardi. Shell subfusiform; spire elongate; mouth scarcely canaliculate behind; lip marginate, nodose or plicate within; columella uniplicate anteriorly and posteriorly; canal short recurved. *F. angulosus*, Brocchi (xlvii, 77). Tertiary; Italy.

MAYERIA, Bellardi. Ovate-fusiform, spire short, but slightly acute; whorls very sharply carinate in the middle; columella smooth, rather straight in front, canal moderate. *F. acutissimus*, Bellardi (xlvii, 81). Tertiary; Italy.

ANURA, Bellardi. Shell turrcted, ovate ventricose; whorls convex; mouth orbicular or suborbicular; lip somewhat arcuate, exteriorly subvaricose in the adult, interiorly margined and smooth; canal scarcely produced; columella slightly contorted, smooth. *F. inflatus*, Brocchi (xlvii, 79). Tertiary; Italy.

MITRÆFUSUS, Bellardi. Elongated, mitræform; spire very long and acute; whorls numerous, the last scarcely depressed in front; mouth narrow, long; lip simple; canal long, produced in the axis of the shell. *F. orditus*, Bell. et Mich. (xlvii, 80). Tertiary; Italy.

GENEA, Bellardi. Shell subfusiform, long, narrow; spire long, very acute; mouth long, narrow; lip simple; columella smooth, but slightly arcuate; canal very short, wide, straight. *F. Bonellii*, Gené (xlvii, 78). Tertiary; Italy.

AFER, Conrad.

Distr.—2 sp. Red Sea to Manilla, Senegal. *A. Blosvillei*, Desh. (xlvii, 82).

Shell short fusiform, spire and canal moderate, body-whorl rather large, shouldered and tuberculate, aperture channeled behind, outer lip dentate within.

Professor Meek (Pal. Hayden's Survey., ix, 344) states that the fossil species described by Conrad, are not congeneric with the type, the recent *Fusus afer*, Lam., and he refers them to Conrad's genus Pyrifusus, one of the forms of Neptuniinæ.

Clavella, Swainson.

Syn.—Clavellithes, Swn. Cyrtulus, Hinds. Triumphis, Gray. Peistocheilus, Meek.

Distr.—*C. serotina*, Hds. (xlvii, 83). Marquesas Is. Fossil. Cretaceous; Missouri.

Shell solid, thick, subfusiform; spire acuminate; last whorl suddenly contracted in front, thickened and rounded next the suture; aperture narrow, canal long and straight; columella excavated in the middle; outer lip simple. Operculum ovate; nucleus apical. Dentition, unknown.

Only one recent species can be referred properly to this fossil genus, which is the *C. serotina*, the type of Hinds' genus Cyrtulus. The three other recent species referred to it by H. and A. Adams are members of other genera: *C. avellana*, Reeve, is a Cronia. *C. distorta*, Reeve, belongs to the Pisaniinæ. *C. subrostrata*, Gray, belongs to the Melongeniinæ.

Peistocheilus, Meek, described as a subgenus of *Fasciolaria*, appears to be identical with Clavella, as Meek himself subsequently suspected. The columellar plaits are nearly obsolete, situated so far within the aperture as to be barely visible and in many specimens are not seen at all. *C. Scarboroughi*, Meek and Hayden (xlviii, 1, 2). Clavella itself occasionally shows these adventitious and inconspicuous plaits. The shell is so decidedly fusiform that I place it in the Fusinæ in preference to the Fasciolariinæ despite these folds.

Buccinofusus, Conrad.

Syn.—Boreofusus, Sars. Troschelia, Mörch, 1876.

Distr.—2 sp. North Sea, Spitzbergen. *B. Berniciensis*, King (xlvii, 84). Fossil. Miocene; U. S.

Shell ventricose, spirally sculptured; epidermis pilose; spire produced; canal moderate in length; columella smooth. The type of this genus is a Miocene fossil, *B. parilis*, Conr.

The dentition, only, separates this from Sipho, several species of which might be regarded as either indentical, or varieties at most.

Jeffreys thus describes the animal: Body white or cream-color, with a slight tinge of flesh-color; mantle sometimes edged with brown; pallial tube extensile, occasionally protruded beyond the

canal, with an expanded or trumpet-shaped opening; proboscis exceedingly long, measuring nearly two inches even when contracted after the death of the animal; tentacles conical, rather short, and close together, with bluntly pointed tips; eyes small and black, seated on long stalks, about half-way up the tentacles; foot lanceolate, thick, rounded and double-edged in front; tail either pointed or blunt and somewhat truncated.

SUBFAMILY *FASCIOLARIINÆ.*

FASCIOLARIA, Lam.

Etym.—*Fasciola*, a band. *Syn.*—Ioeranea, Raf.

Distr.—14 sp. Tropical and Subtropical, world-wide. *F. distans*, Lam. (xlviii, 85). *F. aurantiaca*, Lam. (xlviii, 86). Fossil, 30 sp. U. Cretaceous—.

Shell fusiform; spire acuminated; aperture oval, elongated; canal open, moderate in length, nearly straight; columella smooth, with a few oblique plaits at the fore-part; outer lip internally crenate.

The animal of Fasciolaria does not differ essentially from that of Fusus, nor do we find very much difference in the shells; the usually shorter spire, more swollen body-whorl, wider and shorter and flexuous instead of straight canal, and the oblique plaits near the fore-end of the columella, are the chief distinguishing characters. Between Fasciolaria and Fulgur the resemblance is much closer, and, until the dentition of the two groups became known, they were placed close together by systematists; in Fulgur, however, the scarcely apparent folding of the columella is single, whilst in Fasciolaria it is double, sometimes triple. The Peristerniinæ have columellar folds, but these are usually more transverse, are situated higher on the columella, and the shells are much smaller; indeed one of the characteristics of the Fasciolarias is the comparatively large size of the species, *F. gigantea*, of the southern Atlantic coast of the United States, attaining a length of nearly two feet—the largest of gastropods. The distribution of the genus is tropical and subtropical, in shallow waters. But few living species are known, to which may be added some fossil forms, commencing with the cretaceous. The operculum is more claw-shaped than that of Fusus, and is rather large, filling the aperture.

I have figured the nidimental capsules of *F. tulipa*, Linn. (xvii, 7).

TEREBRISPIRA, Conrad. Shell of medium size, with spire much produced and canal short; volutions convex, angular, and strongly spirally ridged; plaits of columella not exposed externally; outer lip internally sulcated. *F. elegans*, Emmons (xlviii, 87). Miocene; Alabama.

MESORHYTIS, Meek. Shell agreeing nearly with Peistocheilus in form, but with plaits of columella stronger, comparatively little oblique, and exposed directly opposite the middle of the aperture; surface with fine spiral striæ, and vertical costæ. *F. gracilenta*, Meek (xlviii, 88). Cretaceous; Yellowstone River, 150 miles from its mouth. Has the folds of a Mitra, rather than a Fasciolaria, and Meek refers it with considerable doubt to its present position.

CRYPTORHYTIS, Meek. Shell generally under medium size, with volutions convex, but constricted above, and provided with regular vertical costæ or small folds; plaits of the columella very oblique, not exposed in a direct view into the aperture, and occupying a higher position than in the typical group; outer lip smooth within. *F. Cheyennensis*, Meek and Hayden (xlviii, 89, from a cast). Cretaceous; Dakotah.

LIROSOMA, Conrad. Subpyriform; ribbed, beak narrow and produced, slightly recurved; one long, very oblique plait at the angle of the columella. *F. sulcosa*, Conrad (xlviii, 90). Miocene; Maryland.

FASCIOLINA, Conrad. Fusiform; columella nearly straight to the extremity of the beak; one prominent oblique fold on the columella, situated above the middle of the aperture. *F. Woodii*, Gabb. Miocene; New Jersey. The only figure does not exhibit the aperture, but Conrad states that the fold is situated more remote from the beak than in any other genus except Cuma.

SUBFAMILY *PTYCHATRACTINÆ*.

This group was distinguished as a family by Stimpson. The shell of Ptychatractus unites the form of a Sipho with the folds of a Fasciolaria; its small size, color, and northern habitat will distinguish it from the latter, even without taking into account the very diverse dentition; yet without the latter difference it would scarcely have been advisable to have separated the single species upon which the genus was founded from Fasciolaria.

PTYCHATRACTUS, Stimpson, 1865.

Distr.—3 sp. Boreal Atlantic and Pacific. *P. ligatus*, Mighels and Ads. (xlviii, 91).

Shell fusiform, spirally striated; aperture with a moderate canal; columella plicated as in Fasciolaria.

MEYERIA, Dunker and Metzger.

Syn.—Metzgeria, Norman.

Distr.—*M. alba*, Jeffreys (xlviii, 92). Faroë Is., North Sea, Norway.

Shell elongate-fusiform, longitudinally obtusely plicate; spire

produced; canal exserted; columella obscurely plicate. Operculum irregularly ovate; apex obtuse; nucleus inconspicuous.

The dentition of this mollusk appears to relate it somewhat to Ptychatractus, and I prefer to place it in the same subfamily with that shell, rather than make a new family for it. Norman shows that Meyeria is preoccupied by M'Coy for a genus of fossil crustaceans, and he therefore proposes the generic name Metzgeria; but I see no advantage (and much disadvantage) in changing names because they happen to have been previously used in some other department of zoology.

SUBFAMILY *PERISTERIINÆ*.

PERISTERNIA, Mörch.

Distr.—30 sp. Polynesia, Philippines, Australia, Indian Ocean, Zanzibar, Mauritius. *P. nassatula*, Lam. (xlviii, 93). *P. incarnata*, Desh., var. (xlviii, 94). *P. Belcheri*, Rve. (xlviii, 96).

Shell turreted, not umbilicated; whorls longitudinally ribbed; aperture oval; canal moderate and recurved; outer lip thin and crenulated; columella with one or two slight plaits anteriorly. The want of umbilicus, less distinct columella folds and recurved canal are the principal (and not sufficient) distinction from Latirus.

LATIRUS, Montfort.

Syn.—Chascax, Watson. Polygona, Schum., 1817. Plicatella, Swains.

Distr.—34 sp. Polynesia, Philippines, Australia, Indian Ocean, Panama, W. Indies, Madeira. *L. infundibulum*, Gmel. (xlviii, 95).

Shell turreted, fusiform, sometimes umbilicated; spire produced; whorls nodulous, aperture oval-oblong; outer lip thin, crenulated; columella straight, with two or three small oblique plaits in front. Mr. H. Crosse remarks upon the insufficiency of the diagnosis of Latirus by Montfort and H. and A. Adams, and proposes to relegate the species to Turbinella; that genus, however, may be more advantageously restricted to the forms for which the genera Vasum and Mazza have been constituted.

Swainson's group Plicatella has been adopted by Messrs. Adams as a subgenus of Latirus, having "spire moderate, whorls angular, concavely depressed around the upper part," but these are only comparative characters, and I prefer to suppress the group rather than place in it species having no relation thereto, as Messrs. Adams have done. The umbilicus shows more distinctly in most of the species of Latirus than in those of Peristernia, but in some of them it is not any better marked; Latirus, however, differs in form from Peristernia, the species having longer spire and canal, the columella generally straight,

the plications more central, simply because the canal is more produced.

The animals of most of the species that have been observed are of a dull red color.

LEUCOZONIA, Gray.

Distr.—9 sp. W. Africa, W. Indies, Panama. *L. cingulata*, Lam. (xlviii, 97).

Shell oval, subglobose, shouldered; spire moderate; aperture oblong; canal short; columella subflexuous, with small oblique, unequal plaits; outer lip subacute, with a more or less prominent tooth or tubercle at the fore-part.

The most prominent character of this genus, when present, is the tooth which arises from the fore-part of the outer lip. It varies greatly in its development in the different species. In *L. cingulata*, in which it is always present, it is long, curved and tusk-like, so that the species has been erroneously arranged with Monoceros, from which it is instantly distinguished by its claw-like operculum and columellar plaits. In the other species it is sometimes entirely absent in some specimens, whilst well developed in others. There is usually a posterior subchannel to the aperture. The sculpture does not vary essentially from that of the species of Latirus, but the color is usually a chestnut-brown, the only ornamentation being lighter or darker revolving bands. Usually the species are prominently shouldered.

LAGENA, Schum., 1817. Whorls rounded above, not shouldered. *L. smaragdula*, Linn. (xlviii, 98).

Genus MAZZALINA, Conrad, appears to be very similar to *Lagena*, Schum., if not identical with it. *M. pyrula*, Conrad (xlviii, 100). Eocene; Alabama.

FAMILY BUCCINIDÆ.

Shell ovate, oblong or pear-shaped; canal moderate or short, columella without folds or plications.

Operculum with terminal or lateral nucleus.

Dentition 1·1·1. The rhachidian tooth normally three- (sometimes as many as seven-) pronged, the laterals two- or three-pronged (x, 11, 12).

The typical Buccinum is a rather thin ovate shell, uniform and dull in color, with the base of the aperture broadly notched instead of being prolonged (as in Fusidæ) into a canal; but with these have been more recently associated pyriform shells having some resemblance to the latter family. Hemifusus, Melongena, Sipho, etc., pretty well bridge the chasm between the two families as far as the general form of the shell is concerned, but in those species of Buccinidæ approaching Fusus there is the general distinction that the canal, if long, is wide and open;

whilst tortuous as in Fasciolaria, it has at most a single fold in lieu of the plaits on the columella of that genus. I have arranged the subfamilies and genera, commencing with those most closely allied to Fusus, and terminating with the truly buccinoid forms. Although the range of form is great, it will be seen that the transitions are not abrupt; and in this case the lingual dentition affords confirmation of the grouping adopted upon conchological grounds.

Subfamily MELONGENINÆ. Shell pear-shaped, heavy; spire and canal short.

Subfamily NEPTUNIINÆ. Shell rather thin, pear-shaped or ovate; canal moderate and twisted.

Subfamily PISANIINÆ. Shell small, heavy, costate; canal very short and wide, outer lip thickened, dentate within; columella callous or rugose.

Subfamily BUCCININÆ. Shell rather thin, costate or smooth, ovate, covered with a horny epidermis; aperture very large, lip thin, smooth within, terminating below in a short oblique notch.

Subfamily EBURNINÆ. Shell thick, smooth, ovate-oblong; deeply umbilicated or umbilicus covered by a heavy callus; outer lip simple acute.

Subfamily PHOTINÆ. Shell small, smooth, costate or cancellate, ovate or turreted, thick; outer lip striate within; canal short and wide, columella twisted below.

SUBFAMILY *MELONGENIINÆ*.

MELONGENA, Schum.

Syn.—Cassidulus, Ads. Galeodes, Bolt. Mancinella, Mus. Berl. Myristica, Swn. Pugilina, Schum. Volema, Bolt.

Distr.—11 sp. West Indies, Panama, Red Sea, Philippines, Australia, Polynesia. *M. corona*, Gmel. (xlix, 3).

Shell pyriform, solid, dark-colored or banded; spire short, nodulose, spiny; aperture oval-oblong; canal short, open; columella smooth; outer lip simple. Operculum solid, claw-like, nucleus apical.

Kobelt, in his monograph of Pyrula (Conchylien Cabinet), adopts that genus, taking as subgenera Cassidulus (= Melongena), Myristica, Pugilina, Volema and Hemifusus. These groups which (except the last) are too closely related conchologically as well as by their lingual dentition, Troschel also places together, but without subordinating them to a higher group. Pyrula would, indeed, be an excellent name on account of its acceptance years ago for the major part of the species, but unfortunately the first and only species cited by Lamarck in his original description of the genus is the *Bulla ficus*, Linn., which

is a member of the genus Ficula, Swainson, over which it has priority, and instead of which it should therefore be adopted. Cassidulus, Humphrey, has priority over Melongena, but I cannot adopt it as it is a mere catalogue name.

BULBIFUSUS, Conrad. Not characterized. *M. inauratus*, Conr. (= *Fusus Fittonii*, Lea) (li, 49). Eocene; Claiborne, Ala.

CORNULINA, Conr. Not characterized. *M. armigera*, Conr. (= *Fusus Taitii*, Lea) (li, 48). Eocene.

LEIOSTOMA, Swains, 1840. (Sycum, Bayle, 1880.) Fusiform, ventricose in the middle, entirely smooth, almost polished; inner lip thickened and vitreous; base of the pillar very straight. *M. bulbiformis*, Lam. (li, 49). Grignon.

A comparison of numerous specimens indicates the very close relationship of Bulbifusus, Conr., with this group. Bayle has changed the name to Sycum, because Leiostoma is preoccupied by Lacépède in Fishes. I cannot concur in such changes, which would completely unsettle our nomenclature.

HEMIFUSUS, Swainson, 1840.

Syn.—Cochlidium, Gray.

Distr.—6 sp. W. Coast Africa, West Indies, Peru, Philippines, Australia, Indian Ocean.

Shell subfusiform, uncolored or light yellowish; spire shorter than the aperture, ponderous; whorls armed with compressed spines upon the shoulder; aperture long ovate, with an ascending internal canal at the hind-part, produced into a moderate wide canal anteriorly; columella smooth; outer lip simple. Operculum unknown.

Besides being thinner, the shells of this genus are distinguished from Melongena, by being white (without bands or other color-markings) under a light yellowish brown epidermis. They differ from Fusus in the flexuous, wider, open canal, which is widened gradually into the lower portion of the aperture.

THATCHERIA, Angas. Shell angularly pyriform, solid; spire prominent, shorter than the aperture, many-whorled, whorls flattened above, strongly keeled at the periphery and contracted below; aperture with a broad incurved sinus between the extremity of the last keel and the junction of the body-whorl; basal canal wide and open; columella smooth; outer lip simple below the sinus. *T. mirabilis*, Angas (xlix, 5).

That this shell is a scalariform monstrosity cannot be doubted, but what may be its normal form is not so readily ascertained. I saw the single specimen from which the above generic description was made, in London, in 1877, and was immediately convinced that the conical form, flattened shoulders and sinus were all due to distorted growth.

SUBFAMILY *NEPTUNIINÆ.*

NEPTUNEA, Bolten.

Syn.—Chrysodomus, Swains., 1840.

Distr.—18 sp. Circumpolar, Pacific and Atlantic, Europe, Asia, America. *N. antiqua*, Linn. (xlix, 6). *N. decemcostata*, Say (xlix, 7).

Shell fusiform, ventricose; spire elevated, whorls rounded, covered with a horny epidermis, apex papillary; aperture oval; canal short; inner lip simple, smooth. Operculum ovate, nucleus apical.

The shells of this genus are boreal in distribution, and like the other circumpolar genera, are nearly destitute of color, being white or yellowish, under a light brown or yellowish, rather smooth epidermis. The sculpture, when there is any, consists of revolving striæ, ridges or ribs, and the lip of the aperture is smooth within or merely modified by the external sculpture when the shell is thin. In the genus Siphonalia, the species of which are mainly Japanese and Australian, the general form is similar, but the shell is nodose, frequently developing longitudinal ribs, and the outer lip is more disposed to be crenulate; the surface is more usually ornamented with color, disposed in bands, etc. There are some species which can be only arbitrarily placed, having characters partaking of either genus; and in fact geographical considerations must sometimes be allowed considerable weight in assigning such species to their respective genera.

Some of the species are apparently very variable, and it is difficult to decide whether the conservative views of Gwyn Jeffreys and Kobelt, or the more extreme views of Mörch, etc., are most in accordance with truth.

Of *Neptunea antiqua* (xlix, 6), Mr. J. Gwyn Jeffreys (*Brit. Conch.*, iv, 326) says:

"This is good bait for codfish, and a favorite delicacy of the lower working-classes in London. At Billingsgate it is sold under the name of 'almond' or 'red whelk;' according to Rutly's History of Dublin the Irish call it 'barnagh,' the tail (liver) being said to be more fat and tender than a lobster. The egg-cases or capsules overlap one another in an imbricated fashion, each being firmly attached by its base to the underlying capsule; they are deposited in clusters of from a dozen to a hundred, the capsules in each cluster being equal in size. Those which compose one cluster, however, are not half as large as those forming another cluster, although in both cases the fry are in the same state of maturity. When they are dry, the upper or convex side shrivels, and is wrinkled or pitted; the under or flat side (which by contraction becomes concave) is of a silky texture, and divided

across by a few lines; the opening is a wide slit, lying just under the top which makes a narrow flap.

"Before leaving the capsule the fry are perfectly formed, with conspicuous tentacles, eyes, and operculum; their shell has two whorls, the first being smooth, and the other showing a few slight incipient striæ. Each capsule produces only from two to four fry. The latter end of winter appears to be the spawning-season; on the 26th of January, 1861, I examined fresh capsules which contained merely eggs immersed in a glairy liquid; and seven days afterwards I found in the other capsules full-sized and living young whelks."

JUMALA, Friele, 1882. (Chrysodomus, in part.) Central plate small, quadrangular, unarmed, laterals hooked, with two small teeth on the inner margin. *N. Turtoni*, Bean. The dentition forms an insufficient distinction of this group from the typical Neptuneæ.

VOLUTOPSIS, Mörch. (*Syn.*—Strombella, Gray.) Shell smooth, ovate, ventricose; spire short, apex bulbaceous; last whorl rather large; aperture very large, the lip considerably expanded; canal scarcely produced, widely obliquely truncate. Operculum irregularly ovate, with apical nucleus. *N. Norvegica*, Chemn. (xlix, 8).

The shells of this division are characterized by their large mouths, expanded lips, want of distinctly produced canal, etc. The small operculum is (in *V. Norvegica*) more ovate than in the true Neptuneæ; the dentition also, varies from the typical form. Volutopsis appears to stand between Neptunea and Buccinum.

HELIOTROPIS, Dall. (Pyrulofusus, Beck.) Shell thin, sinistral, apex mammillated. Operculum relatively very small.

The essential character of this group is the reversed direction of the spire, placing the aperture on the left instead of the right side of the shell. The principal species have been considered by good conchologists as mere monstrosities of dextral species; thus Mr. J. Gwyn Jeffreys regards *N. contraria*, Linn. (xlix, 9) as equivalent to *N. antiqua*. But of this species it has been shown that it has an extensive distribution in Southern Europe, where the normal *N. antiqua* is unknown, and that the so-called reversed *antiqua* is very rare where the normal form is abundant.

SIPHO, Klein.

Syn.—Atractus, Agassiz. Tritonofusus, Beck.

Distr.—37 sp. Arctic and Boreal, Atlantic and Pacific, Europe, Asia and America. *S. ventricosus*, Gray (xlix, 10).

Shell thin, pyriform or fusiform, not tuberculate or spiny, usually smooth and rounded whorls; spire moderate; canal produced and recurved. Operculum ovate, nucleus apical.

Mr. Gwyn Jeffreys thus describes the egg-capsules of *S. gracilis*, DaCosta:

"The capsules are solitary, small, membranous, pouch-shaped, and attached by a broad base to stones and corallines; their surface is microscopically and closely reticulated; orifice extremely large and sometimes having the edge partly stained with pink. Each capsule contains only a single embryonic shell, which is transparent, and through it may be seen the orange liver and two unequal-sized plumes of pale yellow gills."

NEPTUNELLA, Verrill. Founded on the peculiarly velvety epidermis and the dentition of *S. pygmæus*. The epidermis is, however, no more velvety than in some other species, and the description of the dentition given by Verrill applies very well to that of *Sipho Islandicus*.

SIPHONORBIS, Mörch. Apex depressed, embryonic whorls gradually diminishing, angigyrous. In the true Siphos the apex is mamillary. *S. ebur*, Mörch.

MOHNIA, Friele. Operculum paucispiral. *M. Mohnii*, Friele (xlix, 11, 12).

SIPHONALIA, A. Adams.

Distr.—25 sp. Japan, California, Australia, N. Zealand. *S. Tasmaniensis*, Angas (xlix, 13). *S. nodosa*, Mart. (xlix, 14).

Shell ovately fusiform, sometimes variegated in coloring, rather thin, epidermis very thin, fugaceous; last whorl ventricose, shouldered, usually nodosely plicate and spirally ribbed; aperture oval, outer lip thin, columella smooth; canal rather short, twisted. Operculum ovate, nucleus apical. Dentition unknown.

This genus is principally of tropical and subtropical distribution, and more highly colored than Neptunea: which, nevertheless, it approaches very nearly in the form and color of *S. Kellettii*, for instance. The metropolis of the genus is Japan, a few forms being found, however, on the opposite shores of the West Coast of North America; some species occur also in Australian waters. The shells are usually thin and ventricose, variegated in color and destitute of epidermis. The operculum is fusoid.

AUSTROFUSUS, Kobelt. Shell ovate-fusiform, whorls rounded, not angulated at the upper part. *S. alternata*, Phil. (xlix, 15).

FULGUR, Montfort.

Syn.—Busycon, Bolt.

Distr.—5 sp. Atlantic Coast of United States. *F. carica*, Gmel. (xlix, 16). Fossil. Tertiary; Eastern U. S.

Pear-shaped, thin; spire short, the angle of the shoulder spinous; body-whorl very large, attenuated below into a rather long twisted canal; lip and columella smooth, the latter with a single, rather obsolete fold. Operculum ovate, nucleus apical.

Dentition of typical form; rhachidian tooth 5–6 dentate, laterals 5–6 dentate.

Animal rather small, retractile with its operculum within the shell for about a third of a volution from the aperture.

The distribution of the genus is restricted to the temperate and subtropical waters of the Atlantic Coast of the United States, and its manifest conchological position connects Fasciolaria with Neptunea. It is not infrequent in our miocene deposits, from which several species have been described by Mr. Conrad.

The name Fulgur, meaning lightning, is in allusion to the somewhat tortuous longitudinal brown streaks upon the shells (of Southern specimens), indicating rest-periods in its growth. The animal is used for bait by fishermen, and the trade in the shells for garden ornaments and for use as hanging flower-pots is so extensive as to have nearly caused the extermination of the species upon portions of the New Jersey coast.

Mörch and Adams have used the name Busycon, of Bolten, for this genus, but Bolten did not characterize it, whilst the later name given by Montfort accompanies a full generic description; I therefore prefer Fulgur. It was included by Lamarck in the heterogeneous assemblage of species which he called Pyrula.

The late Dr. Jeffreys Wyman, in his valuable memoir on the "Fresh-Water Shell Mounds of the St. John's River, Florida," mentions two kinds of chisel-shaped tools cut from the shells of *Fulgur carica* and *F. perversa*. These implements were probably used by the aborigines for fleshing skins and for the manufacture of articles of wood. *F. perversa* was also used by the Florida Indians as a drinking vessel, the interior whorls being removed to increase its capacity. This same species was extensively used and must have been an important article of trade among the natives, as it is frequently found in Indian graves and mounds throughout the Southern and Western States and Canada. It is probable that, among other uses, it was cut up into beads and various small ornaments. The white kind of wampum or shell money of the Indians was partially made of the axis of the shells of Fulgur, and partially from *Buccinum undatum*.

SYCOTYPUS (Browne), Gill. Shell with canaliculate suture, periostraca ciliated, nodulous instead of spinous. *F. canaliculatus*, Say (xlix, 17, 18).

I do not consider Browne's description sufficiently characteristic to meet the requirements of a diagnosis; moreover, these shells are known not to inhabit Jamaica. Gill's diagnosis is, of course, accurate, but it mainly repeats the characters of Fulgur; the real difference is in the canaliculated sutures and ciliated

periostracum. The distinction of "spinous" for Busycon or Fulgur, and "tuberculated" for Sycotypus is of little importance generically, as the Fulgurs are frequently only tuberculate when young and become spinous with advancing age; moreover, the miocene series serve to connect the two groups in this respect. Under these circumstances I judge it better to make Sycotypus a subgenus only, under Fulgur.

Mr. T. A. Conrad (*Am. Jour. Conch.*, iii, 182) attempts to distinguish the embryos of Sycotypus from those of Fulgur by the latter having a long fissure parallel with the columella, whilst the columellar region of the former is entire. Mr. Conrad's specimens, which are before me, and which I saw him extract from the pouches, certainly show this difference, but I have since had occasion to examine the embryos of Fulgur several times, and from different strings of pouches, *none* of which show the slit columella; the character was probably pathological.

TAPHON, H. and A. Adams. Shell dextral, transversely striated, whorls rounded; aperture ovate, fore-part produced into a long, slightly recurved canal. *F. striatus*, Gray (xlix, 19).

SYCOPSIS, Conrad. Shell tuberculate, not canaliculate. Eocene and Miocene. Differs from the genus in having tubercles instead of spines on the shoulder.

STREPTOSIPHON, Gill.

Distr.—*S. porphyrostoma*, Ads. and Reeve (xlix, 50). Eastern Seas, Senegal.

Shell subfusiform; spire rather short, apex papillary; whorls angulated at the upper part and tuberculate on the angle; columella concave, with a double very oblique fold on the lower part; canal moderately long, twisted; aperture lirate within. Operculum and animal unknown. Seems to connect Busycon with Tudicla.

TUDICLA, Bolten.

Syn.—Spirilla, Humph. Pyrella, Swn.

Distr.—5 sp. Indian Ocean, China, Australia. *T. inermis*, Sowb. (xlix, 21).

Shell fusiform; spire short, apex papillary; aperture oval; canal very long, narrow, straight; columella smooth, flattened, with a single large, or three smaller transverse folds at the fore-part. Operculum fusoid. Dentition unknown.

PAPILLINA, Conrad. Pyriform; shoulder angular and spinous; beak long, with an obtuse fold on the columella; three volutions from the apex forming a papillated summit. *P. papillatus*, Conrad (li, 58). Eocene; Claiborne, Ala.

PERISSOLAX, Gabb. Spire depressed; body-whorl patulous; canal long; columella without folds or plaits. Distinguished from Papillina by the want of a columellar fold, and evidently

intended to be ranged in the Fusinæ, but I think its general appearance decidedly that of Busycon or Tudicla. Cretaceous to Eocene. *P. brevirostris*, Gabb (li, 59). Cretaceous; California.

LEVIFUSUS, Conrad, is generally considered synonymous with Perissolax. It is an uncharacterized Eocene form. *P. trabeatus*, Conr. Eocene; Alabama.

FUSISPIRA, Hall.

Distr.—*F. ventricosa*, Hall (li, 50). Trenton Limestone, near Green Bay. So far as known, this palæozoic genus is confined to the Quebec, Trenton and Hudson River groups.

Shell fusiform, imperforate, spire more or less elevated, with rounded volutions; aperture elongate, oval or elliptical, produced below, forming a subrimate canal; columella slightly twisted, without folds, peristome sharp. Surface smooth.

CLOSTERISCUS, Meek.

Distr.—*C. tenuilineatus*, Meek (li, 51). Cretaceous; Cheyenne Riv., Dakotah.

Shell thin, fusiform; spire slender, longer than aperture and canal; surface smooth or minutely striate; aperture rhombic, outer lip broadly retreating above the middle, thin, excepting at irregular intervals, where it became thickened and denticulate within, so as to leave internal varices behind as the shell advanced in growth; inner lip very thin, or wanting; columella smooth (?).

PALÆATRACTUS, Gabb.

Distr.—*P. crassus*, Gabb (li, 52). Cretaceous; California.

Pyriform, thick; spire low; columella slightly twisted; outer lip simple, inner lip incrusted. Surface heavily ribbed or cancellate.

PYRIFUSUS, Conrad.

Distr.—*P. subdensatus*, Conr. (li, 53). Cretaceous; Mississippi.

Pyriform; columella broad, thick, flattened; body-volution transversely oval, compressed dorso-ventrally.

NEPTUNELLA, Meek. Body-volution rounded; columella not flattened; spire more elevated; outer lip broadly sinuous above the middle. *P. Newberryi*, Meek and Hayden (li, 54). Cretaceous; Dakotah.

HERCORHYNCUS, Conrad.

Distr.—*H. Tippana*, Conr. (li, 55). Cretaceous; Mississippi.

Shell fusiform; spire prominent, scalariform, longitudinally ribbed and tuberculated, or with tubercles only; top depressed above the angle or shoulder of the last whorl, which depression becomes angular at the aperture, emarginating the upper part of the labrum; last whorl broad and rather abruptly rounded at base; beak abruptly recurved and produced.

LIROFUSUS, Conr.

Distr.—*L. thoracicus*, Conr. = *ducussatus*, Lea (li, 56). Eocene; Alabama.

Genus not characterized.

STREPSIDURA, Swainson.

Distr.—*S. costata*, Swainson = *Fusus ficulneus*, Lam. (li, 57).

Widely fusiform; basal portion of the pillar turned outwardly, with a sharp fold at the base of the aperture; shell costate and subcarinate, body-whorl ventricose.

TORTIFUSUS, Conrad.

Syn.—Meganema, Conr.

Distr.—*T. curvirostra*, Conr. (li, 60). Miocene; N. Carolina.

Differs from Busycon in being without a trace of tubercles or spines, and in having prominent regular ribs; the whorls are flattened on top, and slightly canaliculated.

PYROPSIS, Conrad.

Distr.—*P. perlata*, Conr. (li, 61). Cretaceous; Tippah Co., Miss.

Spire very short, apex not papillated; labrum without striæ within, thick; columella without a fold.

CLAVIFUSUS, Conrad.

Distr.—*C. Cooperi*, Conrad (li, 62). Eocene; Alabama.

The genus has not been characterized.

SUBFAMILY *PISANIINÆ*.

PISANIA, Bivona.

Syn.—Pusio, Gray.

Distr.—20 sp. West Indies, Mediterranean, Red Sea, Philippines, Australia, Polynesia. *P. pusio*, Linn. (l, 22).

Shell oblong; spire prominent, whorls smooth or spirally striated; canal very short; outer lip thickened and crenated. Operculum ovate, nucleus apical.

Between typical specimens of this genus and of Euthria "there is a distinction with a difference," and therefore it may be profitable to retain both groups; but there are species in which the characters become so merged that their generic classification is merely arbitrary.

EUTHRIA, Gray.

Syn.—Evarne, H. and A. Adams.

Distr.—10 sp. Mediterranean, Cape, N. Zealand, Cape Horn, Chili, California, Alaska, Japan. *E. cornea*, Linn. (l, 23).

Shell fusiform, smooth; aperture oval, produced anteriorly

into a long recurved canal; inner lip simple: outer lip posteriorly sinuated, striate within. Operculum ovate, nucleus apical.

METULA, H. and A. Adams.

Distr.—4 sp. N. Zealand, Japan. *M. clathrata*, Ads. and Rve. (l, 24).

Shell elongately fusiform, finely cancellated; spire elevated, acute; aperture narrow; inner lip distinct, smooth; outer lip thickened externally, crenulated within, emarginate posteriorly. Operculum unknown.

CANTHARUS, Bolten.

Syn.—Pollia, Gray. Tritonidea, Swn.

Distr.—55 sp. All tropical and subtropical seas. *C. Tranquebaricus*, Gmel. (l, 25). *C. distortus*, Gray (l, 26).

Shell bucciniform, more or less ventricose in the middle, narrowed anteriorly; spire and aperture nearly equal; columella generally with a few transverse ridges; outer lip internally crenated, and with a superior siphonal canal. Operculum ovate, nucleus apical.

Swainson described a group Tritonidea, which Messrs. H. and A. Adams make a subgenus under Cantharus, distinguishing it from the typical form by "Shell turreted; canal lengthened." The distinction is altogether arbitrary, as the spire in the different species varies considerably from the typical species of Cantharus to much higher, but with no considerable break in the series, whilst the canal can scarcely be called "lengthened" in any of them.

CANTHARULUS, Meek. Shell with canal moderately produced, rather narrow and twisted; inner lip smooth throughout, and rather well developed; columella arcuate and twisted, so as to form an obtuse, undefined prominence below; outer lip slightly sinuous above. *C. Vaughani*, Meek and Hayden (li, 63). Cretaceous; Upper Missouri River.

METULELLA, Gabb.

Distr.—*M. fusiformis*, Gabb (li, 64). Miocene; San Domingo, W. I.

Shell fusiform, canal more or less produced; inner lip covered with a thickened plate, continuous posteriorly with the outer lip. Interior of both inner and outer lips strongly denticulated or transversely striated. Surface cancellate or costate. More distinctly fusiform than Metula, the columella with a row of denticles.

AGASOMA, Gabb.

Distr.—*A. sinuata*, Gabb (li, 65). Miocene; California.

Subfusiform, spire low, body-whorl long; canal moderately

produced and slightly deflected; aperture elongate, labrum simple; labium incrusted with a thin, smooth plate; suture bordered by an elevated portion of the succeeding whorl as in Clavella. It differs from Clavella in the very short spire and in the short and slightly curved canal.

Subfamily *BUCCININÆ.*

Buccinum, Linnæus.

Etym.—*Buccina*, a trumpet.

Syn.—Tritonium, Fabr. Halia, Macgill.

Distr.—22 sp. Arctic and boreal seas; low water to 100 fathoms. *B. undatum*, Linn. (1, 27, 28).

Shell ovate or oblong, covered with a horny epidermis; spire elevated, apex acute; aperture large, oval, emarginate in front; canal wide, very short, or a mere oblique truncation of the base of the aperture; columella smooth; inner lip expanded; outer lip usually thin, smooth internally. Operculum ovate, nucleus small near the outer front edge.

The group of shells to which the generic name Buccinum was originally applied, a century ago, by Linnæus, has been found by subsequent investigation to contain many heterogeneous forms, and has consequently been greatly subdivided. The name has been retained for the genus typified by *Buccinum undatum*, by common consent, and, I believe, in accordance with the best rules of nomenclature. It is true that Linnæus' first species—that which is to be selected, as in cases where no type is distinctly specified—is a Dolium. But in the case of Linnæus' genera, he must be considered to have indirectly specified the type, as he has expressly stated that, in his view, where it becomes necessary to divide a group, formerly supposed to be one genus, the original name must be retained for the subdivision containing the most common species; in other words, that the most common species must be considered as the type of its genus. And he must therefore have regarded the *B. undatum*, the most common of all his Buccinums, as the type of the genus.

The Scandinavian naturalists have generally retained the name Tritonium of Müller for this genus, but Linnæus' name has priority by many years Tritonium, as proposed, and as frequently used since, would include both the Murex and the Buccinum of Linnæus.

The genus Buccinum is restricted geographically to the temperate and frigid seas of the northern hemisphere. Geologically, the history of the genus commences in the Pliocene formation. They are found in the European tertiary deposits of that age, even as far south as the shores of the Mediterranean. They become very numerous in the Pleistocene deposits, both of

Europe and North America, but reach their maximum development in the existing seas.

The shells of the genus Buccinum are peculiarly liable to variation in form and sculpture, and to obsolescence or erosion of the surface markings. This variability, an ordinary characteristic of Arctic shells, renders the discrimination of species extremely difficult.

B. undatum (l, 27, 28) is common to the shores of the northern part of the United States and Europe. Mr. Gwyn Jeffreys writes about it as follows:

"American specimens of the common sort are smaller than European; and Stimpson endeavors to show that they belong to a distinct species, because of 'a *facies* difficult to describe.' If the supposed difference cannot be defined by any words or delineation, and the only substitute offered is the nearly exploded idea of representation of species, it is a pity that naturalists should be so unnecessarily perplexed.

"In Scotland and Shetland this common shell-fish is called 'Buckie,' in the Isle of Man (according to Forbes) 'mutlag,' in Holland 'wulk' (Born), in France 'bouche-aurore' (Lamarck), at Brest 'grosse bigorne,' and at Rochelle 'burgau morchon' (De Montfort), and in La Manche 'ran' (De Gerville). The common generic name in English is 'whelk.' The animal emits a thin and copious slime. From its size and toughness it makes a good subject for anatomical demonstration—although Cuvier has left very little to be known about that part of its history. It burrows in the sand like *Natica catena;* and its foot is similarly traversed by numerous canals, which admit of its being distended by water; this enters by an orifice at the upper corner of the mouth of the shell, and finds its way, through the abdominal cavity, into the vascular system of the foot. When it burrows, the end of the pallial tube or siphon is either exposed or but slightly covered by the sand, so as to supply the gills with water or air as the case may require. Beudant's experiments show that it cannot live in fresh water. The formation of two opercula by the same individual appears to be congenital, and not owing to an injury of the opercular lobe, which would cause an aborted or defective growth; for in some of these monstrous specimens the twin opercula are so large that they are doubled or folded inwards, side by side, in order to fit the mouth of the shell. This mollusk is very voracious, and is often caught on the fishermen's hooks. Orsted tells us, in his interesting treatise, 'De regionibus marinis,' that great numbers of *B. undatum* and *Fusus antiquus* are collected in the Cattegat for fish-bait, by putting a dead cod into a wicker basket and letting it down on a muddy bottom; it is soon taken up half-filled with whelks. The same method is adopted for their capture on the English and Irish

coasts. The whelk affords an illustration of the *lex talionis;* fishes in their turn devour it with equal greediness. I have seen between thirty and forty shells of *B. undatum* extracted from the stomach of a single cod. After the shell has been cleared out and ejected by the fish, it makes a convenient habitation for the hermit-crab. Other nations have not quite so great a fancy as ours for eating the whelk; perhaps it is an indigenous taste; for when the Romans were in this country, they seem to have acquired it—being one which they could not gratify in Italy. Shells of *B. undatum*, mixed with those of the oyster, have been noticed among the ruins of a Roman station at Richborough. At the enthronization feast of William Warham, Archbishop of Canterbury, on the 9th of March, 1504, there were provided '8000 whelks at 5*s.* per 1000.' In the shell-fish market at Billingsgate the present species goes by the name of the 'white' or 'common' whelk, in contradistinction to *Fusus antiquus*, which is there called the 'red' or 'almond' whelk. My obliging informant, Mr. Baxter, says, 'Wilks must be sold the same day we receive them at market in the summer, being the day after they are caught; if the supply is greater than the demand, we boil them, and they keep good for several days.' Evidence was given before a select committee of the House of Commons in the session of 1866, on the 'Whitstable oyster-fishery extension Bill,' that the whelk-fishery on a sandy flat in that bay yielded £12,000 a year—part of the produce being disposed of in the London market for food, and the rest sent to the cod-fishing banks for bait. They are seldom eaten in the northern part of our Isles. At Dieppe and Nantes they may occasionally be seen exposed for sale in the fish-markets. The embryology of *B. undatum* has been investigated by Baster and many other writers. Its curious spawn-cells are figured in Ellis's Corallines as '*Alcyonium seu Vesicularia marina* of Bauhin;' they are also called 'Sea wash-balls,' because of their being used instead of soap by sailors to wash their hands (xvii, 4). Dr. Johnston compares this vesicular mass to the nest of the bumble-bee. It is composed of numerous cartilaginous pouches, of the shape and size of a large split pea, piled irregularly one upon another, and attached by their edges at the base. Cailliaud counted 544 of these cells in one of the spawn-masses. Each cell contains at first several hundred eggs, which are afterwards so greatly reduced in number that only from fifteen to thirty fry come to maturity. The process by which this reduction takes place has been disputed by Scandinavian and English physiologists, not less as to Buccinum than with respect to Purpura. Koren and Danielssen state that the eggs are first spherical, that they afterwards separate into distinct portions, and then amalgamate or agglomerate and assume a different shape. Sir John Lubbock,

on the contrary, ascertained that the more advanced embryos swallow the other yelks whole, and in such quantities as to become greatly distended; his paper in the 'Report of the British Association' for 1860 contains a representation of 'a young embryo in the act of swallowing an egg.' Before the fry leaves its cell, it is furnished with two rounded and ciliated lobes in front, a proboscis, eyes, foot, gills, heart, otolites or ear-stones, and other organs, besides a perfectly formed shell of two whorls and an operculum. The spawning season takes place according to the latitude and climate, between October and May; about two months are required for the development of the fry. The shells vary exceedingly in thickness; some are solid and coarsely ribbed; others are thin, and their sculpture is very delicate. Sometimes the top of the shell is broken off, and the opening is closed by a plug. In young specimens the nucleus of the operculum is more central than in the adult, the lateral extension of growth being inwards or towards the pillar."

The egg-cases of *B. Humphreysianum* are separate and hemispherical, on which account Dr. Jeffreys has proposed to separate that species under the generic name Mada, its surface being glabrous.

BUCCINOPSIS, Jeffreys.

Syn.—Liomesus, Stimpson.

Distr.—3 sp. Northern Europe, Siberia, Alaska. *B. Dalei*, Sowb. (1, 29).

Shell bucciniform, smooth or spirally striulate, last whorl inflated; aperture obliquely truncate below. Operculum small, subtriangular, nucleus apical.

Dr. Jeffreys, who places his genus in the family Muricidæ, remarks that "the principal difference between this genus and Buccinum consists in the operculum, the nucleus of which is in Buccinopsis terminal, at the inner base of the mouth, the increase taking place by semielliptical layers; while in the other genus it is placed within the edge, at the outer side of the mouth, the increase taking place by concentric layers. The egg-cases of Buccinopsis are separate, and shaped like a well-filled leather purse, the opening for the egress of the fry being at the top and very wide."

NEOBUCCINUM, E. A. Smith.

Distr.—The preceding genera, Buccinum and Buccinopsis, are inhabitants of the Arctic sea; this, of the Antarctic waters. *N. Eatoni*, E. A. Smith (1, 30, 31).

Shell bucciniform, smooth, thin; aperture obliquely, widely notched below. Operculum subspiral. Dentition resembling that of Neptunea.

Mr. Smith founds his genus principally upon the paucispiral

operculum, but the figure given by him shows an operculum which is no more curved than occurs sometimes in the genus Sipho, for example. This, with the dentition, indicates relationship with Neptunea, but the absence of a canal in the shell, on the other hand, relates it to Buccinum.

Volutharpa, Fischer.

Distr.—7 sp. Japan, Siberia, Sitka. *V. Perryi*, Jay (1, 32).

Shell ventricose, thin; spire short, body-whorl and aperture very large. Operculum usually wanting; when present, at first with apical nucleus, afterwards becoming annular.

This little group of mollusks is confined in distribution to the North Pacific Ocean, its metropolis being Japan. Three of the species were originally described as Bullia, from which genus it differs in its simple foot and in possessing eyes as well as in dentition. The form and porcellanous texture of the shell are like Bullia, and serve to separate it from Buccinum. Mr. Arthur Adams says that the animal is like Buccinum, of a white color sparsely sprinkled with black on the head, foot and siphon; the tentacles are broad, close together at the base, and rather short, with the eyes on the outer side, near the middle; the siphon is thick and short, and the foot is fleshy and simple behind.

"The ova-capsules of Volutharpa are not at all like those of Buccinum, but rather like those of Fulgur, though smaller, consisting of disk-like capsules, united by one edge to a ribbon or stalk. They contain from eight to twelve embryos, which attain the length of one-half inch, and a shell of two whorls, which, except in the absence of epidermis, essentially resembles the adult. The first whorl, however, is whitish and amorphous, and very fragile; it is large for the size of the embryo, and is invariably lost in shells which have attained maturity. The remainder of the embryonic shell is translucent purplish red, or wine-color, with revolving lines. I found the embryos on the point of escaping from the ova-capsules in September. The disks of the capsules are three-quarters of an inch in diameter and two-tenths of an inch thick, with the edges perpendicular to the top and bottom, and the angles serrate or furnished with slight coriaceous projecting points."—Dall.

Chlanidota, Martens.

Distr.—*C. vestita*, Martens (1, 33). Kerguelen's Island.

Shell subglobose, thin, spirally costate. Operculum with apical nucleus. Dentition: middle plate with five teeth, the outer ones much smaller, laterals with three teeth, the middle one smallest, the outer one somewhat smaller than the inner.

COMINELLA, Gray.

Distr.—20 sp. Cape, N. Zealand, Australia. *C. limbosa*, Lam., var. (l, 34).

Shell bucciniform, marked or spotted, covered with an epidermis; spire short, acute, last whorl large, ventricose, with a posterior depressed groove at the suture, producing a contraction at the hind-part of the outer lip. Operculum with apical nucleus.

H. and A. Adams (*Genera*, ii, 615) make Adamsia, Dunker, a subgenus of Cominella; the operculum and facies of the type show it, however, to = Urosalpinx.

JOSEPHA, Tenison-Woods. Founded upon the *C. Tasmanica*, which differs from Cominella in possessing a plait upon the columella.

CLEA, A. Adams.

Distr.—11 sp. Fresh water. Borneo, Java, Siam, Cambodia. *C. nigricans*, A. Ad. (l, 35).

Shell turbinate, covered by an epidermis, aperture ovately acute, truncate at base and profoundly sinuate, dextral margin regularly arcuate, parietal callus none or thin. Operculum subtrigonal, with apical nucleus.

First proposed as a genus of the family Melanidæ, which the shell resembles in its form, epidermis and habitat in fresh waters, especially reminding one of the genus Hemisinus. The operculum with its apical nucleus, no less than the lingual dentition, whereof the formula is 1·1·1 in Clea, instead of 3·1·3 as in Melania, induced Brot to remove the species to Buccinidæ; and the form and sculpture of the shell do not contravene such a disposition of Clea, its fluviatile distribution being really the strongest argument for considering it a Melania.

CANIDEA, H. Adams. Shell small, fusiform or turbinate, covered with an epidermis; spire longer than the aperture, apex eroded; whorls slightly convex, plicate; aperture elongately ovate, emarginated in front; columella truncate; lip simple, sinuated in front. Operculum small, unguiculate; nucleus apical. Living in fresh water. *C. Helena*, Meder (l, 36). *C. Cambodiensis*, Rve. (l, 37).

ERIPACHYA, Gabb.

Distr.—*E. perforata*, Gabb (li, 66). Cretaceous; California.

Shell short, robust, subovate to subfusiform, spire moderately elevated. Aperture broad, terminating in advance in a very short canal or a mere notch; outer lip simple; inner lip more or less heavily incrusted. Surface marked by longitudinal ribs and revolving lines.

PSEUDOBUCCINUM, Meek and Hayden.

Distr.—*P. Nebrascense*, M. and H. (li, 67). Cretaceous; Moreau R.

Shell oval, thin, ventricose; spire very short; body-volution large, not produced below; aperture large, terminating below in a rounded sinus; outer lip thin and simple; inner lip very thin, smooth, and closely and very broadly folded upon the imperforate umbilical region and body-volution above, so as to form, with a low revolving umbilical ridge, a kind of profoundly arcuate, strongly spiral, false columella; surface with more or less distinct revolving lines and furrows.

Meek is inclined to believe that *Bullia ampullacea* is a living example of his genus; if so, Volutharpa, Fischer, will have priority over Pseudobuccinum.

ODONTOBASIS, Meek.

Distr.—O. ventricosa, Meek (li, 68). Cretaceous; Dakotah.

Shell buccinoid-fusiform; spire more or less produced; body-volution ventricose, and separated below from the short narrow beak, by a sharply-defined, narrow, revolving sulcus, that terminates below at the connection of the outer lip with the canal, in a small tooth-like projection; outer lip thin, smooth within, and nearly straight in outline; inner lip not thickened, but well-defined; columella a little twisted, slightly flattened, and bearing two oblique plaits below, the lower one of which is formed by the raised lower edge of the obliquely truncated columella, and the other, which is very obscure, or perhaps sometimes obsolete, placed a little above the same; surface ornamented by vertical folds and revolving lines and furrows.

This genus, referred doubtfully to the Buccinidæ by Meek, seems to unite characters of several different groups; the shell is Buccinoid in form and sculpture, but the fold and tooth remind one of Fasciolariæ, whilst the truncate columella recalls the Nassæ.

ECTRACHELIZA, Gabb.

Distr.—E. truncata, Gabb (li, 69). Miocene; San Domingo, W. I.

Shell acuminately oblong, spire elevated (always truncated in the only species known). Surface compressed near the suture. Inner lip incrusted; columella sinuous, short; outer lip produced in advance.

This genus seems to be allied in many of its characters to Cominella and Truncaria. Like them, it is compressed adjoining the suture. It shows no trace of umbilicus, as seen in most of the Buccinidæ, but its most distinctive character is in its obliquely subtruncated columella, which does not reach to the anterior end of the shell.

BRACHYSPHINGUS, Gabb.

Distr.—B. liratus, Gabb (li, 70). Cretaceous; California.

Shell bucciniform, short, robust, thick; spire low; aperture large, notched anteriorly; outer lip simple; inner lip incrusted with a smooth callus; surface longitudinally ribbed or striate. Allied probably to Cominella or Volutharpa.

LACINIA, Conrad.

Distr.—*L. alveata*, Conr. = *Pyrula Smithii*, Lea (li, 71). Eocene; Ala.

Globose; pillar lip widely reflected, with a heavy posterior callus; basal emargination profound; base dilated; aperture with a posterior channel; outer lip simple.

This does not differ very much from the recent *Cominella maculata*, Martyn.

HAYDENIA, Gabb.

Dedicated to Dr. F. V. Hayden, U. S. Geologist.

Distr.—*H. impressa*, Gabb (li, 72). Cretaceous; California.

Shell massive, allied, in general form, to Oliva, spire low. Outer lip simple, not thickened nor crenulate; inner lip incrusted, callus marked posteriorly, without teeth or folds; canal slightly recurved; anterior extremity of the mouth notched, and a small sinus at the posterior extremity of the aperture, where the outer lip unites with the body-whorl. Surface ornamented as in some of the Buccinidæ. This curious form is probably a link between Buccinum and Volutharpa.

SUBFAMILY *EBURNINÆ*.

EBURNA, Lam.

Etym.—*Ebur*, ivory.

Syn.—Latrunculus, Gray. Babylonia, Schlüt.

Distr.—14 sp. Red Sea, India, Cape, Japan, China, Australia. *E. spirata*, Lam. (l, 38, 39).

Shell ovate-oblong, thick, porcellanous, under a thin epidermis; deeply umbilicated; spire acuminated, whorls more or less convex, suture more or less channeled; aperture oval; columella arcuated, posteriorly callous; inner lip spreading, often covering the umbilicus in the adult; outer lip simple, acute. Operculum with apical nucleus.

The Eburnæ comprise a small, very well defined group of about a dozen species, the generic character being unmistakable in all of them. The whorls have more or less shoulder; those of *E. Zeylandica*, showing the least, being a mere slight flattening of the contour next below the sutures, whilst in *E. spirata* there is a regular channel out of which arises the preceding whorl. The species are all largely umbilicate, but in some of them the umbilicus is covered or filled, more or less completely, by the callous inner lip; the umbilical region is defined by a strong rib. A thin,

dark brown epidermis, sometimes translucent, covers the livin shell, but cabinet specimens are usually denuded of this, exhib iting upon an ivory-white surface, spots and maculations o orange-red. The aperture is usually white, sometimes tinge with violet upon the columella. This pattern of coloring is mos uniform throughout the genus; but the species are distinguishe by modifications of the arrangement of the color-spots, as wel as by the differences of shoulder and umbilicus. None of th species are strictly banded, although in some the coloring coa esces into irregular revolving masses. The coloring remind one strongly of Phasianella, whilst the shell, except for the wan of its characteristic groove and tooth, recalls the genus Pseudo liva—one of the species of which was formerly erroneousl referred to this group. The surface of the shell is invariabl smooth, devoid of the sculpture of ribs, striæ, tuberculation etc. The operculum is ample, filling the aperture. The Eburn are natives of the tropical seas of the Eastern hemisphere.

ZEMIRA, H. and A. Adams. Umbilicus moderate; outer li with a tooth near the fore-part. The revolving channel near th base of the shell, ending in a tooth-like projection on the oute lip, has induced Sowerby to class this species in the genu Pseudoliva; it seems nearly related to Eburna, however. *E Australis*, Sowb. (1, 40).

Macron, H. and A. Adams.

Distr.—4 sp. California, W. Patagonia. *M. Kellettii*, A. Ad (1, 41).

Shell ovate, solid, with a thick epidermis; spire elevated; colu mella wrinkled, with a callosity at the upper part; outer lip thin with a small tooth anteriorly. Operculum ovate, with apica nucleus.

This was originally described as a subgenus of Pseudoliva which it resembles in having an inferior revolving groove termi nating in a small tooth-like projection of the outer lip; th operculum, however, is unguiculate like that of the Eburna whilst that of Pseudoliva is purpuroid. The more decided cana and absence of sutural channel, and the rather persistent blackis brown epidermis, will distinguish it from the subgenus Zemir of Eburna. Its locality, West Coast of America, is also distinctive character; Eburna being East Indian, and Pseudo liva African in distribution.

Subfamily *PHOTINÆ*.

Phos, Montfort.

Etym.—*Phos*, light.

Syn.—Rhinodomus, Swn. Strongylocera, Mörch.

Distr.—20 sp. All tropical and subtropical seas. *P. senticosus*, Linn. (l, 42, 43).

Shell cancellated, oblong, acuminated, usually longitudinally ribbed; outer lip striated internally, with a slight sinus near the fore-part; columella obliquely grooved, or with a single plait in front. Operculum claw-shaped, nucleus apical.

The animal of Phos has a small head, with the tentacles approximating or connate at their base, and eyes near their tips; foot dilated, forming an auriculate, shield-like lobe in front, and terminating behind in a long, tapering filament.

The species of Phos bear some resemblance to Nassa, and were originally placed in the family Nassidæ; from which, however, they are distinguished by certain good conchological and malacological characters. The turreted form, cancellated surface and grooved interior of aperture are common to Nassa also, but the oblique basal fold of the columella is characteristic of this genus. The animal differs from Buccinum in the foot, ending in a filament behind: Nassa has a bifid posterior termination.

NASSARIA (Link), H. and A. Adams.

Syn.—Hindsia, Ads.

Distr.—10 sp. Indian O., China, Japan, Philippines. *N. acuminata*, Rve. (l, 44).

Shell ovately fusiform; spire acuminated, whorls longitudinally ribbed and cancellated; aperture ending anteriorly in a long recurved canal; inner lip thin, circumscribed, transversely corrugately plicated; outer lip grooved internally. Operculum ovate, nucleus apical.

Animal with the tentacles connate at the base, with the eyes near their distal ends; foot anteriorly produced, ending behind in a simple tail without filament.

This genus partakes of the characters of several recognized forms. Its animal, however, differs from that of Triton in the approximated tentacles, with the eyes near their ends, and the anteriorly produced foot; from that of Nassa in the tail not being bifurcated. In its shell it may be known from Phos by its recurved canal; from Nassa by its circumscribed inner lip and elongated canal; and from Triton by its want of irregular varices.

CYLLENE, Gray.

Distr.—10 sp. Indian O., China, Philippines, W. Africa. *C. lyrata*, Lam. (l, 45, 46).

Shell ovate; spire short, acute, suture canaliculated; columella concave, smooth or finely grooved; outer lip with a slight sinus at the fore-part, emarginate posteriorly, grooved internally. Operculum with terminal nucleus. Dentition unknown.

The species of Cyllene inhabit the intertropical coasts of Africa,

the Malaysian Archipelago, etc. They live with the **Nassas** along shore-lines and do not appear to inhabit great depths. The animal, which is unknown, is supposed, from the sutural slit which characterizes the shell, to possess a mantle provided with a prolongation or fold occupying the slit, somewhat analogous, perhaps, with that of Oliva. The operculum of *C. lyrata* is elongated, rhomboidal, with terminal nucleus, externally concave, internally convex.

CYLLENINA, Bellardi, 1882. Spire more produced, the last whorl about half the length of the shell; parietal wall of the aperture concave, without lip; columella terminating anteriorly in an oblique truncation, which is usually ridged. 12 sp. Tertiary; Northern Italy. *C. Ancillariæformis*, Grat. Appears to connect Cyllene with Nassa.

BUCCITRITON, Conrad.

Syn.—Sagenella, Conrad.

Distr.—*B. cancellatum*, Lea = *sagenum*, Conr. (li, 73). Eocene; Alabama.

Genus not characterized. One of the typical specimens of *B. sagenum* has a single varix on the back of the body-whorl, but the other specimens are without it, so that its non-absorption may be regarded as accidental. *B. altum* is a different type of shell entirely, and looks something like a Truncaria.

FAMILY NASSIDÆ.

Shell ovate, spire usually elongated, base of aperture a notch or short recurved canal, inner lip usually callous. Operculum corneous, ovate, nucleus apical, margins plain or serrated. Animal having two small processes or tails at its posterior extremity. Lingual teeth arched, pectinated; the uncini with a basal horn, and occasionally intermediate serrations. Dentition (x, 13).

Many fossil species are known, commencing with the Eocene.

NORTHIA, Gray.

Distr.—3 sp. Panama, Philippines. *N. serrata*, Dufresne (lii, 74).

Shell elongated, turreted, polished; spire elevated, acuminated, whorls depressed and sloping at their upper part; aperture shorter than the spire; outer lip with the margin serrated. Dentition unknown.

This genus is in its general aspect much closer to Pusionella in the family Terebridæ than to the genera with which it is here (and has been heretofore) associated; the variceal thickening at or near the outer lip is, however, a feature which does not

obtain in the Terebridæ. Pusionella, moreover, has a concentric operculum, with its nucleus near the middle of the inner margin. Perhaps the figured operculum of Northia is abnormal; it has that appearance. I think that if these shells had not been assigned to the Nassidæ or to any other family, I would have placed them in Terebridæ; as it is, I prefer to allow them to remain here, rather than possibly complicate the subject by changing their position.

TRUNCARIA, Ads. and Reeve.

Distr.—6 sp. Philippines, Panama, L. California. *T. modesta* Powis (lii, 75).

Shell acuminately oblong, thick; suture of the spire channeled; aperture anteriorly dilated, posteriorly subemarginated; columella arcuated, abruptly truncated in front, with a single anterior fold. Dentition unknown.

BULLIA, Gray.

Distr.—25 sp. S. Africa, Indian Ocean, E. and W. Coast of S. America, Taheiti. *B. callosa*, Gray (lii, 79).

Animal without eyes; tentacles long and slender. Foot enormously expanded, and bifid behind in the typical species. Operculum pointed, nucleus apical.

Shell ovate or turreted; spire more or less acuminated, sutures enameled; inner lip excavated in the middle, callous posteriorly; aperture oval, moderate.

Bullia (restricted) has a raised band of enamel round the sutures of the whorls, as in Ancillaria. The animal has the faculty, according to M. Quoy, of absorbing, through the pores of its foot, a great quantity of water, which it ejects, when disturbed, in various directions; it is caught by baiting lines with bits of flesh. The genus is Oriental, mostly S. African in distribution, and reminds one of the Arctic genus Volutharpa.

In Woodward's "Manual of the Mollusca," Bullia is erroneously made a synonym of Anaulax, Roissy, a fossil form of Ancillaria.

BUCCINANOPS, d'Orb. Shell with the whorls somewhat angulated, and with a rounded or nodulous band next the sutures. Embraces three species from the southern parts of the Coast of South America. They are of rude growth, usually with a flattened shoulder below the sutures. *B. annulata*, Lam. (lii, 77).

PSEUDOSTROMBUS, Klein. (Leiodomus, Swains.) Shell elongated, smooth, without epidermis, last whorl ventricose; spire acuminate; aperture ovate, columella arched, smooth or transversely striated, outer lip thin. No enamel round the sutures. *B. polita*, Linn. (lii, 78).

ADINUS, H. and A. Adams. Shell subulate, spirally striated; columella abruptly truncated at base; inner lip corrugated, with

a callosity at hind-part; outer lip grooved internally, externally marginated. *B. truncata*, Rve. (lii, 76).

MOLOPOPHORUS, Gabb. Short, robust, spire moderately elevated, suture bordered by a more or less distinct carina. Surface longitudinally ribbed or striate. Aperture obtuse behind, and very slightly notched; outer lip simple, inner lip very slightly incrusted, sinuous, anterior notch small, but distinctly defined. *B. striata*, Gabb (lii, 80). Cretaceous; California.

[BULLIOPSIS, Conr. Placed by its author at first as a subgenus of Nassa, it was subsequently removed by him to Melanopsidæ. It has some resemblance to Bullia.]

NASSA, Lam.

Distr.—131 sp., of world-wide distribution. Fossil, numerous species. Eocene—. *N. mutabilis*, Linn. (lii, 81).

Shell ovate, ventricose, body-whorl variously sculptured; aperture ovate, with a short, reflected, truncated, anterior canal; inner lip smooth, often widely spread over with enamel, with a posterior callosity or blunt dentiform plait; outer lip dentated, internally crenulated. Margin of operculum serrated or entire.

The animal of Nassa has a broad head, and a foot quadrately expanded in front, with the corners often pointed, whilst behind it bifurcates and is prolonged frequently into two subulate tails. The operculum is usually serrate on the margin, but is sometimes plain. The Nassæ are very active, and not at all shy when kept in confinement. They may be occasionally seen floating with the foot upwards. They are predaceous, feeding on other mollusks, the shells of which they bore. I have frequently seen the shells of the American species themselves bored, the hole being of such a size as to suggest cannibalism. Perhaps the avenger of their misdeeds is a beautiful and very active hermit crab which disports itself in the Nassa's shell, immense multitudes being seen at low tide in the water near the shore-line. Whether begged, borrowed, stolen, or lawfully captured by the red right claw, it is certain that, at Atlantic City, New Jersey, the hermit inhabits a vast majority of the specimens of Nassa occurring to the collector. Although most of the species are littoral, a few have been collected at considerable depths; *N. brychia*, Watson, was dredged at 620 fathoms by the "Challenger Expedition." Some of them have been observed to spring up and throw themselves over on being suddenly disturbed. Usually they glide along the surface of the mud, leaving a track indicating their line of march, at the end of which is a small round pellet; under this the creature conceals itself. The fry twist and twirl about by means of their ciliated lobes. *N. mutabilis* is an article of food in Italy. The generic name is that of a narrow-necked wicker basket used for catching fish, and in such a basket, lob-

ster pots, etc., the Nassa itself is frequently caught, attracted thither by odors savory.

Nassa reticulata is said to be very destructive in the oyster-parcs of Arcachon (France). It is so numerous that a single tide has yielded 14,600 specimens within a space of 40 French hectares (= about 100 acres). The adult Nassa will bore through the shell of an oyster three years old within eight hours; but the young shells are far more destructive, because they select the tender shells of the very young oysters, sometimes piercing fifteen or twenty in succession before their hunger is satisfied. An oyster a month old is destroyed in a half-hour.

According to M. Lespés, *N. reticulata* is preyed upon by a parasitic Trematode (*Cercaria sagitata*) which infests its liver. Its spawn-cases are deposited on the leaves of Zostera and on various other things which are left dry only at spring-tides; the capsules are arranged in rows, and so closely that they overlie each other "like the brass scales of the cheek-band of a hussar" (Johnston). They are compressed pouches, each of the size of a large spangle, supported on a very short stalk, with a small opening at the top to allow the fry to escape. Mr. Peach has given us some amusing particulars of the fry. These behaved themselves like the fry of other gastropods, skipping about and whirling round by means of their ciliated lobes, apparently in a state of pleasurable excitement; but it seems that the exercise was compulsory or necessary to prevent the attacks of a swarm of infusoria, which made short work of any tired or feeble infant Nassa.

The following "subgenera" may be retained as convenient group designations, although the species, varying much in their sculpture, cannot always be positively assigned:

ARCULARIA, Link. (Eione, Risso.) Body-whorl gibbous on the back; spire produced; callus of inner lip greatly extended and covering the spire. *N. Thersites*, Brug. (lii, 82, 83).

NAYTIA, H. and A. Adams. Shell smooth; aperture with a channel at the hind-part continued up the spire. *N. glabrata*, Sowb. (lii, 84).

ALECTRION, Montf. (Monoceros, Fleming.) Spire elevated, whorls glabrous, polished or papillary; inner lip spreading; outer lip denticulate, not variced externally. *N. glans*, Linn. (lii, 85).

ZEUXIS, H. and A. Adams. (Telasco, H. and A. Adams. Nassodonta, H. Adams. Zaphon, H. and A. Adams.) Spire elevated, smooth, or longitudinally plicate, polished; inner lip with the callus defined, or somewhat spreading; outer lip externally variced, sometimes dentate anteriorly. *N. canaliculata*, Lam. (lii, 86, 87).

ACICULINA, H. and A. Adams. Shell turreted, polished, smooth,

or longitudinally plicate; inner lip with the callus sharp, straight, defined; outer lip produced in the middle, variced externally. *N. maculata*, A. Adams (lii, 88).

PHRONTIS, H. and A. Adams. Spire elevated, acuminate, whorls ribbed or nodulous, distinctly shouldered; inner lip smooth, with an extended, thickened callus, outer lip with an external varix. *N. luteostoma*, Brod. and Sby. (lii, 89).

HEBRA, H. and A. Adams. Whorls spinose, muricated or sharply tubercular; inner lip with the callus defined; outer lip with a marginal varix, when adult. *N. muricata*, Quoy (lii, 90).

HIMA, Leach. (Tritonella, A. Ad.) Spire elevated, whorls cancellated; inner lip with a rugose callus, callus defined; outer lip with a marginal varix. *N. Tritoniformis*, Kiener (lii, 91).

NIOTHA, H. and A. Adams. Shell cassidiform; spire short, whorls granulated or cancellated; inner lip with the callus very large and spreading; outer lip crenate, not variced externally. *N. Kieneri*, Desh. (lii, 92).

TRITIA, Risso. (Uzita, H. and A. Adams.) Spire elevated, whorls reticulated; inner lip smooth, with the callus moderate; outer lip simple, not variced. N. *trivittata*, Say (lii, 93).

ILYANASSA, Stimpson. (Cæsia, H. and A. Adams. Schizopyga, Conrad.) Shell dark olive-brown, reticulated, outer lip without varix, striate within, columella covered with a spreading callus. Operculum with entire (not serrated) margin. Animal having a broad foot, not bifurcated behind as in Nassa. *N. obsoleta*, Say (lii, 94).

The characters proposed by Stimpson include an operculum without serrated margin, and the animal without posterior bifurcation. Although the operculum is usually serrated in *Nassa*, Mr. Marrat has enumerated a dozen species in which it has been observed to have plain margins, or nearly so; and Dr. von Martens states that the European *N. reticulata* is found in the mud-flats of the Venetian lagunes with the operculum plain on one side and somewhat serrated on the other, and that the end of the foot is but slightly notched in these specimens instead of being deeply bifurcated. Under these circumstances, it becomes very doubtful whether the group Ilyanassa ought to stand. I have concluded to retain it provisionally, especially as it may include several species conveniently separable from Tritia by having dark-colored shells.

The animal of the common American species, *N. obsoleta*, Say, is variously mottled with slate-color, the tentacula are suddenly diminished above the eyes, and become bristle-like. Its movements are very active, and it collects in numbers about dead crabs and other marine animals, on which it feeds. Inhabits all our muddy shores, preferring situations not exposed to the surf of the open sea; such as inlets and extended flats which are

drained at low tide. It is found abundantly at the confluence of fresh and salt water, where the taste is merely brackish. No shell of equal size is so abundant on the whole Atlantic shore. The younger shells are most likely to be collected, because the old ones become very much eroded and defaced, and a greenish mould-like plant vegetates abundantly upon them. Very few, therefore, of the shells usually collected, have the lines on the interior of the outer lip. The ova-capsules are laid during April and May, are of transparent corneous texture, singly attached to the inside surface of a valve of Mactra, or the inner face of the nidus of Natica; they are deposited in vast numbers, completely covering the object to which they are attached and crowded together promiscuously.

VENASSA, von Martens. Base with a callous spiral deposit encircling the indented umbilicus. *N. pulvinaris*, von Mart. Timor.

PTYCHOSALPINX, Gill. Shell ovate, buccinoid, whorls regularly rounded and ventricose; spire moderate (about as long as the aperture), furnished with equal revolving linear ridges, siphonal canal very short, very obliquely twisted and concurrent with the siphonal fasciole; aperture rhombo-ovate, oblong; labrum entire, not sinuous, smooth within; columella inversely sigmoidal, concave near the middle, with a very thin callous deposit and with a revolving linear plait in front. Dr. Gill refers this group to the family Buccinidæ, but I agree with the late Mr. Conrad that his description indicates (as do the types cited) Nassæ. *N. scalaspira*, Conrad (lii, 95). Miocene; Virginia.

PARANASSA, Conrad. Differs from Ptychosalpinx in the submargin of the labrum being slightly thickened within and striate; siphonal canal shorter. Eocene, Miocene; America and Europe. *N. granifera*, Conr. (lii, 96). Virginia. As one of the two specimens of the type of Paranassa is striate within the aperture, while the other is smooth, probably the distinction from Ptychosalpinx will not hold good.

TRITIARIA, Conrad. Elongated, subturreted, labrum not thickened within. This does not seem to differ generically from the true Nassas; it has very little resemblance to Ptychosalpinx. *N. peralta*, Conrad (lii, 97). Miocene; Virginia.

NERITULA, Plancus.

Syn.—Cyclops, Montf. Cyclonassa, Swains. Nana, Schum. Cyclocyrtea, Agass.

Distr.—3 sp. Mediterranean, Black Sea. *N. neritea*, Linn. (lii, 98, 99).

Shell ovate, depressed, axis distorted; spire flattened, oblique, whorls smooth; aperture depressed; columella smooth; inner lip

callous, spread over the body-whorl, outer lip reflected, not denticulate or striated.

In Neritula the last whorl is depressed and extends over the penultimate whorl, nearly covering and concealing the spire, which consequently appears very obtuse. The animal has a bifid tail, and operculum similar to Nassa. H. and A. Adams' genus Teinostoma was originally placed next to Neritula, in their "Genera;" subsequently they removed it to the Rotellidæ.

DESMOULEA, Gray.

Distr.—6 sp. Senegal, Cape of Good Hope, Japan. *D. abbreviata*, Wood (lii, 100).

Shell ovate-globose, covered with a downy epidermis; spire short, conical, apex papillary; whorls depressed; aperture ovate; inner lip thickened, with a ridge posteriorly; outer lip contracted, thickened externally, plicated internally. Dentition unknown.

Desmoulea is remarkable for its obtuse apex and solid growth, much resembling some species of Cassididæ; when in fine condition, the shell is clothed with a velvety epidermis, but most cabinet specimens are denuded of this. The animal is unfortunately unknown, and therefore the systematic position of the genus remains somewhat uncertain—for, whilst some species connect closely with Nassa, the revolving sculpture, globose form, sunken suture and mouth of others are suggestive of Semicassis.

FAMILY TURBINELLIDÆ.

This group includes a few ponderous tropical species, allied in the characters of the mouth, and in general form and ornamentation, to the Peristerniinæ on the one hand, whilst in size they approach the Volutidæ. The plications on the middle of the pillar are rather distant, narrow, high, and transverse, whilst in Fasciolariinæ they are situated lower, are not so prominent, and oblique in direction. The epidermis is frequently persistent.

The animal (of Vasum) is slow-moving, timid and inactive, shrinking quickly within the shell on the slightest alarm. The operculum is ovate, acute, with an apical nucleus; it is very thick, claw-like, and partially free at the hind-part. The dentition (x, 14) resembles somewhat that of the Buccinidæ, differing in the lateral teeth; it differs widely from the Nassidæ, and quite as much from that of the Fasciolariinæ or Peristerniinæ.

TURBINELLA, Lam.

Etym.—Diminutive of *turbo*, a top.
Syn.—Mazza, Klein. Rapum, Swains.

Distr.—4 sp. Indian Ocean, Coast of Brazil. *T. pyrum*, Linn. (lii, 1).

Thick, obconic, smooth, last whorl large; spire obtuse, apex papillary; aperture oblong, narrow; canal long and straight; columella with several strong, transverse plaits in the middle; outer lip thin, simple. Animal unknown.

The shankh or chank (*Turbinella pyrum*) is the sacred shell of the Hindoos, and the national emblem of the Kingdom of Travancore. The god Vishnu is represented as carrying a chank shell in one hand and a chakra in the other.

The principal demand for these shells is for making bangles or armlets and anklets, and the manufacture is still almost confined to Dacca. The shell is cut or sliced into segments of circles, or narrow rings of various sizes, by a rude semicircular saw, the hands and toes being both actively employed in the operation. Some of these bangles, worn by the Hindoo women, are beautifully painted, gilded and ornamented with gems.

The shell rings are coated inside with plaster to smooth the roughness. Filagree-bordered edges of plaster are also added, patterns and devices of red, blue and gold are figured on them, and they are further ornamented with silver or gold tinsel, spangles, small colored glass beads, etc. The larger bracelets, formed of many segments, are made to open to admit the hand, by two spiral pins, which unscrew and let out the piece. These bangles are not removed at death, and hence there is a continual demand for them, many wearing several, both on the legs and arms.

The mammillary apex of the shell is made into a button or bead; the latter are called krantahs, and necklaces of these are so commonly worn by the Sepoys in the British East India service as almost to be deemed a regular part of their uniform.

CARICELLA, Conrad. Columella-folds decreasing in size from above, as in Mitra, base canaliculate and not emarginate. The small group of fossils referred to it may be said to resemble Turbinella in essential characters, the difference being that the folds are situated lower down on the pillar, and that the shell is thinner. *T. prætenuis*, Conrad (lii, 2). Eocene; Claiborne, Alabama.

VASUM, Bolten.

Syn.—Cynodonta, Schum. Scolymus, Swains.

Distr.—7 sp. Zanzibar, Brazil, West Indies, Panama, Philippines, Indian Ocean, Mauritius, Polynesia. *V. cornigerum*, Lam. (lii, 3).

Shell oval, oblong, solid, tubercular or spinose, with spinose fascioles below; spire short, apex not papillary; aperture oblong; canal short, somewhat recurved; columella with several transverse folds in the middle; outer lip thickened and sinuous.

Family VOLUTIDÆ.

Shell turreted, aperture notched in front, columella obliquely plaited; no operculum in the larger species. Animal with recurved siphon, foot very large, partly hiding the shell, eyes on the tentacles or near their bases. Dentition (x, 7).

Cymbium, Klein.

Boat-shell. *Syn.*—Yetus, Gray.

Distr.—5 sp. W. Mediterranean, W. Coast of Africa. *C. proboscidale*, Lam. (liii, 4; i, 15).

Shell oval-oblong, ventricose, thin; spire short, nucleus large, globular, forming an obtuse papillary apex; whorls few, forming a flat edge around the nucleus; aperture oblong, wide; columella with several oblique plaits; outer lip thin, simple.

The animal is large, compared to the size of the shell, when expanded. The foot partially covers the shell, which is sunk into its substance. There is no operculum. Ovoviviparous, the young when born being of a large size and covered with a shell with a large irregular callous apex. They leave the parent when they have attained a length of about an inch, the brood appearing to consist of four or five individuals. Adanson observes that the high winds of April cast the "yet" up in such vast quantities as sometimes to cover the shore, the natives of Senegal using them as food.

Cymbium is separated from Melo by its flat or slightly channeled shoulder and want of coronal spines. When fresh, the epidermis is more or less covered by a thin glaze deposited by the enveloping mantle.

Melo, Humphrey.

Distr.—10 sp. Indian Ocean, Australia, etc. *M. tessellata*, Lam. (liii, 5).

Shell large, subovate, ventricose, thin; spire short, apex obtuse, papillary, persistent; whorls smooth, the last posteriorly coronated; aperture oblong, wide; columella with several oblique plaits, the anterior the largest; outer lip simple, acute, obliquely truncate in front. No operculum.

The apex of the shell is spiral, regular, very different from the shapeless apex of Cymbium. This genus, like Cymbium, is ovoviviparous, the young ones being arranged in the oviduct of the female in a long string, without egg-shells.

Voluta, Linn.

Syn.—Volutolyria, Crosse. Scaphella, Swains. Scapha, Gray.

Distr.—About 75 sp. Indian Ocean, Japan, Alaska, Australia, Eastern Polynesia, Atlantic Coasts of Southern South America, to West Indies, Southern Africa, etc. No species exist in the

seas of Europe, although they were numerous during the tertiary epoch; *V. abyssicola*, an African species, is the sole surviving representative of the group to which most of these small tertiary species belonged. Australia is the metropolis of the Volutes, and, as M. Crosse remarks, a triangle the respective points of which shall include Ceylon, Japan and New Zealand will cover the habitat of about 80 per cent. of the species. Fossil, 250 sp. Cretaceous; Europe, Asia, N. America. *V. musica*, Linn. (liii, 6).

Shell ovate or subconical, thick, solid; spire usually short; shoulder of whorls usually angulated, sometimes nodose or spinous; aperture generally rather narrow; columella with a callous deposit and plaited; lip generally thickened, sometimes subreflected.

Animal having eyes on lobes at the base of the tentacles; siphon with a lobe on each side at its base. Usually no operculum (there is an operculum in *V. musica*, Linn.).

This genus is oviparous, at least the South American species are so, and M. Duhant-Cilly has given us some interesting particulars concerning them. He noticed the Volutes in clear shallow water in Magellan's Straits, and, with the aid of natives, procured specimens—which nearly all grasped dead shells of *Venus exalbida*, a common bivalve of that locality. Upon examining these shells they were found to contain within the cavity of one of the valves, a round, slightly convex membrane, comparable for size and transparency with a watch-glass. The contents appeared to be merely a milky fluid in some cases, but in others, the egg having advanced further in development, three or four small, but perfectly formed Volutes could be seen swimming in the fluid, which had become transparent. D'Orbigny also collected large numbers of these eggs, and in the month of February saw the young Volutes, four or five in number, in each. The containing membrane, which becomes corneous, he describes as 80 to 100 millimetres in length, more than half the size of the animal which lays it, and he conjectures that it expands after coming into contact with the water.

VOLUTA (typical), Gray. Longitudinally plicate, plicæ becoming prominent on the shoulder, columella with four or five principal plaits, and several smaller ones. Operculum (of *V. musica*) fusoid, narrowly elongated, with terminal nucleus. *V. musica*, Linn. (liii, 6).

HARPULA, Swains. Shell oval-conic, spire with a papilliform but small summit; columella with larger plaits below, and additional smaller ones above, but less numerous than in the preceding section; exterior lip thickened within, sharp without. *V. vexillum*, Lam. (liii, 7).

FULGORARIA, Schumacher, 1817. Shell oblong-fusiform; spire

moderately elongated, terminated by a papillary summit with the apex lateral, instead of central and vertical as usual in spiral shells; surface plicate longitudinally, crossed by engraved revolving lines; columellar plaits six or seven, or more; lip thickened within, its margin slightly crenulate. *V. rupestris*, Gmelin (liii, 8).

VESPERTILIO, Klein. Shell oval-oblong, more or less ventricose. Spire terminated by a regularly spiral summit, papilliform, but having an apparently crenulated nucleus, caused by the presence of numerous little tubercles, more or less apparent. Columella four-plaited. *V. vespertilio*, Linn. (liii, 9).

AULICA, H. and A. Adams. Agreeing with the preceding section in general form and principal characters, the summit of the spire differs in having a completely smooth instead of a tuberculated surface. *V. imperialis*, Lam. (liii, 10).

AMORIA, Gray. Shell fusiform, smooth and polished; spire conical, with a small, more or less pointed nucleus; sutures slightly callous; columella with five oblique, more or less developed plaits. *V. undulata*, Lam. (liii, 11).

ALCITHOË, H. and A. Adams. Shell oval-fusiform, spire elongated, terminated by a papilliform summit; aperture oval-elongated, inner lip covered by a callous deposit, outer lip expanded and more or less reflected; columella with four, and more rarely five to seven oblique plicæ. *V. Pacifica*, Solander (liii, 12).

CYMBIOLA, Swainson. Shell oval, thin, recalling the form of Cymbium. Spire more or less elongated, terminated by a slight irregular, papilliform summit. Aperture large, the columellar side covered with a slight coat of enamel; columella usually with four oblique plications; outer lip sharp, occasionally slightly expanded. An American, and principally Antarctic group. *V. ancilla*, Solander (liii, 13).

VOLUTELLA, d'Orbigny. Shell smooth, subcylindrical, with angulated whorls; spire acuminated, polished, and entirely covered by an enamel deposit, obliterating the suture-line more or less entirely; columella with three oblique plaits; lip sharp, not reflected. The development of a lobe of the mantle to cover the spire is a peculiarity in this animal not shared by the other groups of the genus. *V. angulata*, Swainson (liii, 14, 15).

PSEPHÆA, Crosse. Shell oblong-fusiform, very finely transversely striated and furnished with longitudinal ribs, disappearing towards the middle of the last whorl. Nucleus (?). Columella furnished with two principal plicæ, above which there are two or three minute ones hardly visible; it presents also this peculiarity (in the adult shell), that these plicæ are situated so far within as to be invisible when the shell is placed right in face of the

observer. Internal margin strongly callous; external lip obtuse and thickened. *V. concinna*, Brod. (liii, 16).

AUSOBA, H. and A. Adams. Spire short and obtuse, terminated by a papilliform summit; last whorl coronated. *V. cymbiola* (Chemn.), Sowb. (liii, 17).

VOLUTILITHES, Swains. Shell oval-fusiform, spire elevated, terminated by a pointed summit; whorls cancellated or longitudinally plicate; mouth oval-oblong; columella with numerous rudimentary or obsolete plicæ; lip thin. The group is represented by a single living species and numerous tertiary forms. *V. abyssicola*, Adams and Reeve (liii, 18).

VOLUTOCONUS, Crosse. Oblong, subcylindrical, longitudinally and transversely striate; spire short and obtuse, terminated by a rounded summit; columella with four slightly developed teeth; lip simple, slightly inflected in the middle; base with flexuous striæ. *V. coniformis*, Cox (liii, 19).

CALLIPARA, Gray. Shell oblong, subcylindrical; spire short, nucleus small; columella with two plications. *V. bullata*, Swainson (liii, 20).

MAMILLANA, Crosse. Shell widely oval, ventricose, rather thin, intermediate between Voluta and Cymbium; nucleus papilliform, very strongly developed, excentric and lateral; columella with a few oblique plicæ; lip thin. *V. mamilla*, Gray (liii, 21).

PROVOCATOR, Watson, 1882. Shell smooth, fusiform; having the apex of Ancillaria, the enameled suture of Bullia, the pillar-folds of Voluta, and the sinus of Pleurotoma. *V. pulcher*, Watson. Kerguelen Island.

WYVILLEA, Watson, 1882. Shell ovate, cymbiform, thin, rough; spire high scalar; apex mammillate and irregular; suture canaliculate; mouth large, ovate; inner lip with a wide-spread thinnish callus; pillar perpendicular, with a very slight turn, with no teeth, but an abrupt break of the edge about the middle of its length. Differs from Cymbiola in the texture of the shell, which is extremely delicate, but rough, in the canaliculate suture, and toothless pillar. *W. alabastrina*, Watson. Marion Island.

The following fossil groups are enumerated by W. M. Gabb. They should probably all be considered as subgeneric under Voluta rather than as distinct genera.

VOLUTODERMA, Gabb. Shape similar to Fulgoraria, which it also resembles more or less in surface-sculpture; apex not papillate; inner lip marked by from three to five well-marked folds, not very oblique, and of pretty uniform size. This is a group of shells characteristic of the cretaceous rocks and perhaps peculiar to them. They are all somewhat slender, and are marked by longitudinal ribs; the columella is always straight or nearly so, and the folds are as isolated and distinct as those of Turbinella.

But the most strongly distinguishing character is the entire absence of the irregularly rounded mass at the apex of the shell, one of the best characters of Fulgoraria. Cretaceous of United States, Europe and India. *V. Navarroensis*, Gabb. (liv, 26). California.

VOLUTOMORPHA, Gabb. Shell elongate, fusiform; whorls cancellated by longitudinal and revolving ribs; columella with one very oblique fold, and sometimes one or more smaller secondary folds. *V. Conradi*, Gabb (liv, 29). A cast. Cretaceous; New Jersey.

ROSTELLITES, Conrad. Narrow, subulate, with elongated spire, numerous subequal plaits on the columella, and the outer lip somewhat expanded anteriorly. *V. Texana*, Conr. (liv, 28). Cretaceous; Texas.

VOLUTIFUSUS, Conrad. (Megaptygma, Conr.) Fusiform; body-whorl finely striated or smooth, with the exception of the shoulder, which is sometimes tuberculated; columella plaited, folds two to three, sometimes very prominent, oblique; apex papillated; initial whorl acute, subspiral, narrow; beak produced, recurved or sinuous. Miocene of Europe and America. *V. typus*, Conrad (liv, 29). North Carolina.

ATHLETA, Conrad. Ovate, Voluta-shaped; spire short, acute; columella with plaits as in Voluta; a callus projecting on the shoulder, and covering a portion of the spire. Cretaceous; Miocene of Europe. *V. Tuomeyi*, Conrad (liv, 30). Mississippi.

LEIODERMA, Conrad. Shell largely covered with enamel; with very oblique columellar folds; outer lip somewhat emarginate on the upper part to its junction with the body-whorl; base deeply emarginate. *V. leioderma*, Conrad (liv, 31). Cretaceous; Mississippi.

PTYCHORIS, Gabb. Differs from Athleta in the want of the characteristic callus, in being subglobular instead of subfusiform and angulated, with very oblique folds on the anterior part of the columella. *V. purpuriformis*, Forbes (liv, 32). Cretaceous; India.

[FICULOPSIS, Stoliczka, referred by him to the Volutidæ, is a Ficus with the addition of columellar folds. I agree with Mr. Gabb in including it in the Ficulidæ = Pyrulidæ.]

PLEIOPTYGMA, Conrad. Subfusiform; aperture long; columella with very oblique plaits, numerous, alternated in size, or irregular; the largest being the second one from above. *V. Carolinensis*, Conrad (liv, 33). Miocene; South Carolina.

CRYPTOCHORDA, Mörch. Shell smooth, Volutiform, enameled; columella without plications. Tertiary. Seems to connect Voluta with Harpa. *V. stromboides*, Gmel. (liv, 34). Tertiary; France.

GOSAVIA, Stoliczka. Shell convolute, spire turbinated, last

whorl inversely conical; aperture narrowly elongate, base emarginate; lip sinuate at the suture; columella plicated, anterior plicæ strongest. Cretaceous; Europe and India.

Stoliczka refers this group to Conidæ, as he does also doubtfully Imbricaria and Cylindra, which he considers closely related. The two latter are known to be in no way closely related to Conus, and Gosavia possesses every characteristic of a Volute; indeed I cannot separate it readily from such forms as *V. musica*. *V. Indica*, Stol. (liv, 35). India.

LYRIA, Gray.

Distr.—16 sp. W. Indies, E. Africa, Indian Ocean, Japan, Australia, W. Coast of Central America. *L. Delessertiana*, Petit (liii, 22).

Shell ovately fusiform, solid; spire acuminate; whorls longitudinally ribbed; aperture ovate, rather narrow; columella with numerous transverse plaits, two lower ones much the largest; outer lip externally ribbed. Operculate.

The species are smaller than in Voluta, and Mitræform, connecting with the genus Mitra.

ENÆTA, H. and A. Adams. Outer lip thickened, inflected and bearing an obtuse tooth upon its middle inner margin. *L. harpa*, Barnes (liii, 23).

MICROVOLUTA, Angas.

Distr.—*M. Australis*, Angas (liii, 24, 25).

Shell small, ovately fusiform, solid, smooth, shining; spire as long as the aperture, apex papillary; whorls simple; aperture narrowly ovate; columella with four strong transverse plaits, the anterior one the smallest; outer lip thin, simple, slightly contracted at the base; base rounded, spout-shaped, with a flexuous bend upwards towards the columella, which is a little thickened and reflected below the plaits. The deep siphonal notch and the toothed projection of the base of the pillar, so characteristic of Voluta, are here wanting.

The above description is drawn up from the only known species, and probably many of its characters are of slight importance. The animal is unfortunately unknown.

FAMILY MITRIDÆ.

The animal has a small, narrow head; tentacles close together at the base; eyes near the base or towards the outer middle of the tentacles; proboscis cylindrical, flexible, very extensible, mantle enclosed; siphon simple at the base; foot small, triangular, usually truncate in front.

The dentition of the Mitridæ (x, 9) presents several distinct types; so that Troschel and Gill have divided the family upon

this character. The group Cylindra has the teeth of Marginella and is placed near that genus by these authors; the form of the shell also recalls Marginellidæ, and although the preponderance of characters accords with Mitra, it may be reasonably considered a connecting link with Marginella. Volutomitra has been placed in Volutidæ on account of the dentition of *V. Grœnlandica*, the only Arctic species of Mitra, but I have preferred to retain it and its congeners in Mitridæ, because we know nothing of the dentition of numerous tropical species referred to it. Turricula and Strigatella are allied by their dentition to the Olividæ, and Imbricaria to the Turbinellidæ.

Some of the larger species have no operculum, but it is often present, though small and rudimentary, on the foot of the smaller species.

Shell with acute apex, usually well developed spire and plicate columella; for the most part destitute of epidermis, which is very thin, smooth and translucent when present.

Mitra is related on the one hand with Voluta, on the other with Marginella; it is distinguished from the former by its columellar plaits, of which the largest are posterior whilst in Voluta they are anterior, by its form, and the apex, which is never papillary; from Marginella it is distinguished by its much longer spire, less polished surface, generally larger size and particularly by wanting the thick marginal varix of the lip.

Mitra, Lamarck.

Syn.—Thiarella, Swains. Mitraria, Raf. Mitrolites, Krug. Isara and Ziba, H. and A. Ad.

Distr.—Over 200 sp. Tropical and subtropical, but a few small species being found in the colder latitudes. Bathymetrically they range from low-water to eighty fathoms, the smaller species being usually found along shore-lines. About a hundred fossil species have been described, commencing with the cretaceous period. *M. episcopalis*, Lam. (lv, 36).

Shell fusiform, thick; spire elevated; aperture small, narrow, notched in front; columella transversely, somewhat obliquely plicate; outer lip thick, smooth within, not variced externally.

The animal of Mitra has in general a very short foot, straight and continuous from side to side in some species, but in others notched and produced, with a thickened anterior margin. It is commonly narrow and rounded, or acuminated posteriorly, and it often bears a very small semitransparent horny operculum, in some instances scarcely visible. The siphon is mostly directed forward, and the somewhat short, tapering tentacles have the eyes either situated about half-way, or they are placed on the outer side of the base. The head is long and very flat, and the tentacles are very close together at their bases. The proboscis

is rarely exserted when they are crawling and lively, but as they become languid after capture it becomes distended with water and protrudes considerably. When irritated, some species of Mitra emit a purple fluid having a nauseous odor.

The Philippine Islands would seem to harbor the greatest number of these elegant and beautiful shells, although a great many species were obtained by Mr. Cuming in tropical America. They appear to be chiefly confined to the equatorial regions, scarcely any being natives of cold climates. The transversely ribbed species are frequently found in very deep water, and many have been dredged in twenty and thirty fathoms at the Sooloos and in the China Sea.

The Mitridæ inhabit various stations; many being strictly reef shells, where they lurk in holes and crevices under sea-weed, but are most generally concealed under stones and blocks of dead coral. Others burrow in sand or sandy mud at various depths; some delight in stony ground inside the reefs, where they remain concealed under clumps of coral during the day, and like the sand species are nocturnal in their habits.

Although M. Quoy has rightly termed the Mitra an "animal apathique," the small longitudinally ribbed species crawl about pretty briskly over the smooth sand among the low coral islands. The *Mitra episcopalis* (lv, 36), probably on account of the small size of its locomotive disk, and the ponderous nature of its long shell, is, however, a very sluggish mollusk. Some of the Auricula-shaped Mitres that live among the Philippines, in the shallow pools left by the receding tide, crawl about the stones out of the water, in company with Planaxis and Quoyia. The Mitres, like many of the large Volutes, prefer, however, to associate together, and may be seen in dozens crawling over the sandy mud-flats in shallow water, being most active just as the flood-tide makes. When the tide recedes, they bury themselves superficially in the yielding soil, and are with difficulty discovered. Some of the small ribbed species cover themselves entirely with the sandy mud, and in that disguised condition travel about with comparative security.

MITRA (typical). Mitriform, thick, spire elevated, apex sharp; mouth rather small and narrow, notched in front; columella obliquely plicate; lip rather thick, smooth within.

[VOLUTOMITRA, Gray. Separated from Mitra on account of the peculiar dentition of an Arctic species, *V. Grœnlandica.* Twenty additional species have been included in the group by H. and A. Adams; they are all Mitras in appearance, and the dentition of none has been examined, except that of *V. cornea*, which decidedly differs from *V. Grœnlandica*, and is of the regular Mitra type.]

AIDONE, H. and A. Adams. Shell fusiform, smooth, polished,

small; spire acuminate, as long as the aperture; inner lip excavated, with two prominent plaits in the middle; outer lip thin, simple. *M. alba*, Pease.

SWAINSONIA, H. and A. Adams. (Mitrella, Swains.) Oliviform, smooth, polished, spire nearly as long as the aperture. *M. fissurata*, Lam. (lv, 37).

SCABRICOLA, Swainson. Mitre-shaped or pyramidal, granulated or scabrous. *M. granatina*, Lam. (lv, 38).

CANCILLA, Swainson. Shell fusiform, slender; whorls having revolving elevated ridges, and no longitudinal ribs; outer lip thin, not dentate within. *M. filosa*, Lam. (lv, 39).

CHRYSAME, H. and A. Adams. Shell ovate, spire and aperture usually about equal in length; whorls encircled by rounded ribs; inner lip with a few strong transverse plaits; outer lip with the margin crenate. *M. coronata*, Lam. (lv, 40).

STRIGATELLA, Swainson. (Mitreola, Swn.) Shell Columbelliform, smooth, uncolored or with brown longitudinal flames and maculations. *M. paupercula*, Lam. (lv, 41).

ZIERLIANA, Gray. Ovate or Columbelliform, solid; spire short, acute, last whorl tumid at the hind-part; columella with a posterior callosity; outer lip thick, flattened, lirate-dentate within; a sinus or short canal posteriorly. *M. robusta*, Reeve (lv, 42).

FUSIMITRA, Conrad. Uncharacterized. *M. cellulifera*, Conrad (lv, 43). Oligocene; Vicksburg, Miss.

CONOMITRA, Conrad. Uncharacterized. *M. fusoides*, Lea (lv, 44). Eocene; Claiborne, Ala.

THALA, H. and A. Adams.

Distr.—12 sp. Polynesia, Philippines, Mauritius, Panama. *T. mirifica*, Reeve (lv, 45).

Small, narrowly fusiform, sculptured or smooth, last whorl attenuated and recurved below; outer lip thickened, straight or incurved in the middle, lirate internally, with a slight sinus at the hind-part. Dentition unknown.

MITROIDEA, Pease.

Syn.—Mauritia, A. Ad. Mutyca, H. and A. Adams.

Distr.—6 sp. Polynesia, Philippines, Mauritius. *M. ancillides*, Swains. (lv, 46).

Shell mitriform, smooth, spire acuminated; aperture narrow, linear; columella with numerous, small oblique plaits, narrowed and turned to the left at the base; outer lip thickened, peculiarly truncated and recurved at the base. Dentition similar to that of Mitra.—MACDONALD.

Mitroidea is closely allied to Dibaphus, but the latter has a shorter spire, and is without columellar folds.

DIBAPHUS, Philippi.

Distr.—*D. Philippii*, Crosse (lv, 47). Polynesia, Mauritius.

Subcylindrical, covered with a thin epidermis, transversely sculptured; spire acute; aperture narrow, linear; columella without plaits, narrowed and turned to the left at base; outer lip thickened, rectilinear, abruptly truncated and recurved at the base.

Differs from Mitroidea in the columella being without plaits. It resembles in general form *Conus mitratus*, as well as more distantly *Strombus terebellatus*, and formerly had a position between Conus and Mitra, but the animal does not differ from Mitra. Like that genus, when plunged living into alcohol it yields a fine purple dye.

TURRICULA, Klein.

Syn.—Callithea, Swains. Vexillum, Bolt. Tiara, Swains. Vulpecula, Blainv.

Distr.—162 sp. Exclusively tropical and subtropical, its metropolis being Central Polynesia. *T. plicaria*, Linn. (lv, 48).

Shell elongated, turreted, longitudinally plicately ribbed; spire acuminated; aperture narrow; columella with numerous plaits; outer lip internally striated.

COSTELLARIA, Swainson. Shell smaller, with elevated spire, body-whorl anteriorly contracted, slightly ventricose in the middle, aperture sometimes striated within. *T. exasperata*, Chemn. (lv, 49).

PUSIO, Swains. Shell small, ovate, more or less ribbed or nodulous, spire usually short, convex, with obtuse apex; outer lip sometimes thickened. *T. luculenta*, Reeve (lv, 50).

LAPPARIA, Conrad. Uncharacterized. *T. dumosa*, Conrad (lv, 51). Eocene; Jackson, Miss.

CYLINDRA, Schum., 1817.

Distr.—8 sp. Red Sea, Indian Ocean, China, Philippines, Polynesia, Mauritius. *C. fenestrata*, Lam. (lv, 52).

Shell oliviform, subcylindrical; spire conical; aperture linear; columella straight, with several oblique anterior plaits; outer lip thickened, smooth within.

IMBRICARIA, Schum., 1817.

Syn.—Conœlix, Swains.

Distr.—9 sp. Philippines, Polynesia. *I. marmorata*, Quoy (lv, 53).

Shell coniform, often covered with an epidermis; spire depressed conical, apex mucronate; aperture linear; columella straight, with numerous transverse imbricated plaits in the middle; outer lip thickened.

Distinguished by its Conus-like form, the columella with less numerous plaits than in most of the species of Cylindra; some species, like *Cylindra dactylus*, however, appear to connect these two forms.

FAMILY MARGINELLIDÆ.

Shell porcellanous, polished, usually smooth or with longitudinal ribs; spire short or immersed, body-whorl ample, aperture nearly the length of the shell, the outer lip with usually thickened margin, smooth or dentated within, the inner lip with several distinct plaits on the columella.

Animal with tentacles close together at the base, the eyes above the base or near the middle of the tentacles, mantle with expanded side-lobes covering the back of the shell as in Cypræa; siphon elongate, foot large, truncate in front, produced behind. Operculum none.

Dentition (x, 6). In possessing rhachidian pieces without laterals, the lingual armature of Marginella resembles that of Voluta, whilst the shape of the plate and its dentated edge are very similar to that of Mitridæ—lateral teeth being added in the latter family. A single species of Erato (the only one examined) possesses three lateral teeth on each side like the Cypræidæ, and on this ground some systematists place Erato in that family. *Marginella glabella* sometimes possesses an operculum, but generally does not have it; some of these operculate specimens also have a single lateral tooth on each side of the rhachidians on the lingual ribbon. Pseudomarginella, Carriere, is founded upon specimens possessing this very different dentition; the shell does not differ at all from specimens of *M. glabella* in which the dentition is normal.

The shell being covered by the mantle-lobes receives a polished surface and is devoid of epidermis, thus resembling externally the Cowries and Olives, whilst the plaits on the columella connect the family with Mitridæ.

ERATO, Risso.

Distr.—17 sp. Europe, West Indies, So. Africa, Indian Ocean, Philippines, Polynesia, Tropical W. America. Fossil. Eocene—; Europe. So. Australia, N. America. *E. lævis*, Donov. (lv, 54).

Shell obovate, polished; spire short, conical, distinct; aperture linear; outer lip without varix, but thickened towards the middle, and denticulated within; columella with distinct plaits at the fore-part.

ERATOPSIS, Hœrnes and Auinger. Shell granular-tuberculate, with a longitudinal sulcus on the back of the body-whorl, as in Trivia. Includes five living species, and several forms from the Austrian tertiary. *E. Schmeltziana*, Crosse (lv, 55).

MARGINELLA, Lamarck.

Etym.—Diminutive of Margo, a rim.

Syn.—Volvarina, Hinds. Eratoidea, Weink. Egouena and Serrata, Jousseaume. Bullata, Jouss. Granula, Jouss. Canalispira, Jouss. Balanetta, Jouss. Porcellanella and Microspira, Conr. Pseudomarginella, Carriere, 1881.

Distr.—200 sp. Tropical and subtropical; Caribbæan, West African, Indo-Pacific, etc. Fossil, 75 sp. Cretaceous (?), Eocene—; United States, Europe, Australia. *M. glabella*, Linn. (lv, 56).

Shell ovately oblong to subcylindrical, smooth, polished, sometimes longitudinally ribbed; spire short-conical or concealed; aperture narrow, elongated, obtuse or truncated in front; columella plicate; outer lip with a thick marginal varix, its inner margin smooth or crenulated.

GLABELLA, Swainson. Volutiform, spire more or less conic, well developed, usually longitudinally plaited about the shoulder of the body-whorl; pillar with distinct basal plaits; lip thick, toothed or crenate, rarely smooth within. *M. Adansonii*, Kiener (lv, 57).

PRUNUM, H. and A. Adams. Shell smooth, oval, spire slightly prominent; outer lip thick, unarmed, inner lip frequently forming a callous deposit; color light gray or yellowish gray, usually without distinct bands or spots; exterior lip-margin sometimes orange-brown. *M. marginata*, Born (lv, 59, 60).

CRYPTOSPIRA, Hinds. Shell swollen, smooth, spire very short, nearly concealed; columella five- or six-plaited; outer lip thickened, smooth within; color gray or yellowish olivaceous, usually without bands, sometimes interruptedly banded or strigate. Nearly related to Prunum, but differs in having a shorter spire, less callous deposit and more columellar teeth or plaits. *M. elegans*, Gmel. (lv, 58).

VOLUTELLA, Swainson. Bulliform, ovate-oblong; spire depressed; pillar with four oblique plaits at the fore-part, lip smooth within. *M. bullata*, Born (lv, 61).

PERSICULA, Schum. Shell Bulliform, spire depressed or sunken; usually banded or spotted; aperture long, the outer lip generally denticulated within, with a posterior channel, inner lip with a callosity posteriorly, four plaits anteriorly, with smaller ones behind them, becoming obsolete. *M. persicula*, Linn. (lv, 62).

GIBBERULA, Swainson. Shell suboval; spire slightly prominent, outer lip posteriorly dilated and gibbous, not denticulated. A group of small species differing from Persicula in the spire being slightly prominent instead of sunken. *M. miliaria*, Linn.

CLOSIA, Gray. Spire involute; lip thick, usually dentate within; columella heavily incrusted with callus, the two lower plaits very prominent, two upper ones not so prominent, above them there are sometimes false folds or transverse ridges as in

Cypræa. The dorsal aspect is much like Cypræa. *M. sarda*, Kiener (lv, 63).

VOLVARIA, Lam. (Hyalina, Schum.) Shell subcylindrical, spire very short or concealed; outer lip of aperture without varix or thickening. *M. avena*, Gmel. (lv, 64). *M. bulloides*, Lam. (lv, 65).

FAMILY OLIVIDÆ.

Animal with a recurved siphon and voluminous foot, its lobes usually reflexed over the sides of the shell, and fissured on each side in front. Dentition (x, 15).

Operculum corneous, small; frequently wanting.

Shell brilliantly colored, porcellanous, without epidermis, the columellar lip, sutures and spire more or less covered with a callous deposit; outer lip simple, notched below.

SUBFAMILY *OLIVINÆ*.

Head and tentacles more or less concealed; mantle with a tapering lobe in front, and a posterior appendage which reposes in the channeled suture.

Operculum present in Olivella, absent in the typical Oliva.

Shell solid, smooth, subcylindrical, sutures channeled, inner lip more or less plicate anteriorly.

OLIVELLA, Swainson.

Rice-shell. *Syn.*—Olivina, d'Orb. Micana, Gray.

Distr.—31 sp. N. Carolina, W. Indies, W. Coast of America, Senegal, China, Philippines, Australia, Polynesia. *O. undatella*, Lam. (lvi, 66).

Shell polished, small; spire produced, acute, suture canaliculated; aperture narrow behind, enlarged anteriorly; columella plicated in front, callous posteriorly.

Animal without tentacles or eyes, mantle with a large frontal lobe; foot not very voluminous, truncate behind, the shield narrow, the side-lobes small and acute.

Operculum horny, thin, half ovate, with apical nucleus.

Olivella is distinguished from Oliva by the small size of its shell, its more produced spire, the presence of a large, thin, horny operculum, and the want of eyes. D'Orbigny has observed *O. Tehuelcha* suddenly expand the lobes of its foot, and using them to beat the water like the wings of the pteropods, dart rapidly through the element.

OLIVA, Brug.

Syn.—Dactylidia, H. and A. Ad. Ispidula, Gray. Porphyria, Bolten. Strephona, Browne. Dactylus, Klein. Galeola and Carmione, Gray.

Distr.—55 sp. Subtropical; East and West America, W. Africa, India, China, Polynesia. Fossil. Eocene—. *O. erythrostoma*, Lam. (lvi, 67).

Shell oblong, subcylindrical, polished; spire short, conic; suture canaliculated; aperture long and narrow, anteriorly widely notched; columella obliquely plicate, sulcate or striate in front, posteriorly callous; outer lip simple.

Animal with tentacles enlarged at the base; mantle with a posterior filament lodged in the channeled suture of the spire; foot long and acuminate behind, shield with the side-lobes tapering, acute, small.

Operculum none, in the restricted group.

Like most shells enveloped in the voluminous foot of the animal, Oliva has no epidermis. The shell has an under layer with different pattern of coloring, but this is never exposed except in worn specimens, or else artificially by the aid of acids: hence it is evident that unlike the Cypræa, which changes its pattern upon becoming mature, the two layers of Oliva are simultaneously produced at all stages of its growth. The interior volutions are often absorbed till they become of paper-like tenuity in order to accommodate the increasing bulk of the animal.

LAMPRODOMA, Swainson. (Ramola, Gray.) Spire acuminate, elevated, suture canaliculated; inner lip simple posteriorly, but regularly, numerously plicate anteriorly, the plicæ more transverse than in the typical group. *O. volutella* (lvi, 68—the only species) is found in vast numbers over many acres on the sandy beach west of the city of Panama. Some time after the retreat of the tide, it is found crawling about with much vivacity on the wet sand. The shell, while the animal is moving, is wholly covered with the foot-lobes, and these are entirely concealed with a thick coat of sand. When the first wave of the returning tide strikes them, washing off this coating, they instantly bury themselves.

CALLIANAX, H. and A. Adams. (Scaphula, Gray.) Shell swollen, ovate, with short conical spire and channeled sutures; aperture wide, effuse in front; inner lip with a very thick, defined callus, and a few frequently indistinct anterior plaits. 2 sp. W. Coast of America, Patagonia. *O. biplicata*, Sowb. (lvi, 69).

AGARONIA, Gray. (Tortoliva, Conr. Hiatula, Swains.) Shell thin, oliviform, but a little effuse anteriorly; spire acuminate; aperture rather wide, effuse below; columella not thickened posteriorly, tumid, with a few oblique plaits in front. Has a small operculum. *O. hiatula*, Lam. (lvi, 70).

OLIVANCILLARIA, d'Orb. (Utriculina, Gray. Lintricula, H. and A. Adams. Scaphula, Swains. Anazola and Claneophila, Gray.) Shell smooth, wide, oblong, last whorl swollen; spire

very short, the suture not canaliculated to the apex; aperture rather large and wide, inner lip somewhat tortuous, with a large callosity behind, incurved in the middle, and two or three oblique anterior plaits. Head and tentacles concealed; mantle with a large, thick, fleshy appendage behind, partially covering the spire; foot very voluminous, truncate posteriorly, shield with the side-lobes very large and rounded. Operculum small, half ovate, with subapical nucleus. Appears to connect Oliva with Ancillaria. Brazil, W. and S. Africa. *O. Brasiliana*, Lam. (lvi, 71).

PLOCHELÆA, Gabb. Shell olive-shaped, suture nearly obsolete, as in Ancillaria; spire short; outer lip internally thickened in the middle; inner lip callous, with several transverse folds, of which the upper are smallest; columella strongly recurved at the base, like a Dibaphus. *P. crassilabra*, Gabb. Tertiary; West Indies.

SUBFAMILY *ANCILLARIINÆ*.

Head concealed; eyes none; tentacles rudimentary; mantle with a tapering lobe in front; foot voluminous, bifid behind, shield-grooved on the upper surface, side-lobes not much produced. Operculum small, ovate, acute, sometimes entirely wanting. Shell usually polished; sutures covered by callus; whorls smooth; aperture effuse, the columella variously grooved and twisted in front.

MONOPTYGMA, Lea.

Syn.—Not Monoptygma, Gray. Chiloptygma, H. and A. Ad.

Distr.—Fossil. Eocene; United States. *M. Alabamensis*, Lea (lvi, 74). One recent species, *M. exigua*, Sowb., is possibly a monstrosity.

Shell with elevated spire and callous columella, the latter with a subcentral conical tooth-like callous projection. Dr. Lea's second species of his genus is an Actæon.

ANCILLARIA, Lam.

Etym.—*Ancilla*, a maiden.

Syn.—Ancillopsis, Conr. Sparella, Gray. Anaulax, Roissy. Ancilla, Lam. Amalda, H. and A. Adams. Sandella Gray.

Distr.—17 sp. Red Sea, Indian Ocean, Australia, Japan, West Indies. Fossil. Eocene—; U. S., Eur. *A. Tankervillei*, Swains. (lvi, 73).

Shell oblong or subcylindrical, thick and smooth in the typical species; body-whorl usually swollen; sutures covered by enamel; aperture broadly effuse below; columella (typically) not umbilicated, with a few oblique anterior plaits. The revolving basal groove ends occasionally in a slight anterior labral projection or tooth.

OLIVULA, Conrad. Shell decussated by distinct close, longitudinal and revolving striæ; spire covered by a longitudinally striate callous deposit, forming a raised band upon the suture of the body-whorl; aperture posteriorly channeled. Fossil only. *A. staminea*, Conr. (lvi, 72).

ANOLACIA, Gray. (Cymbancilla, Fischer.) Shell oblong-ovate, thin; body-whorl swollen, irregularly covered with slight revolving striæ; spire very short, callous. Somewhat resembles the genus Cymbium. *A. Mauritiana*, Sowb. (lvi, 75).

DIPSACCUS, Klein. Shell solid, polished; columellar lip twisted, separated from the body-whorl by a tortuous fissure opening into the umbilicus above; outer lip with a slight tooth in front. *A. glabrata*, Linn. (lvi, 76).

ANCILLINA, Bellardi, 1882. Spire produced, body-whorl rather short; on all the whorls is a narrow channel close to the suture; columella uniplicate. *A. pusilla*, Fuchs. Tertiary; Northern Italy.

ANCILLARINA, Bellardi, 1882. Shell narrowly elongated, subcylindrical, with short spire; anterior area defined by an oblique sulcus which terminates in a tooth on the outer lip. *A. suturalis*, Bon. 2 sp. Tertiary; Northern Italy.

SUBFAMILY *HARPINÆ.*

Head and tentacles exposed; eyes conspicuous; mantle simple, enclosed, without a tapering appendage in front; foot large, flat, not reflexed on the sides of the shell. No operculum. Shell large, ventricose, longitudinally ribbed; columellar lip without anterior plications or grooves. Dentition (x, 16).

HARPA, Lam.

Harp-shell.

Syn.—Harpalis, Link. Harparia, Raf. Lyra, Griffith.

Distr.—9 sp. Tropical; Mauritius, Philippines, Ceylon, Polynesia, West Coast of America (absent from the tropical Atlantic O.). Fossil. Eocene—. *H. ventricosa*, Lam. (lvi, 77).

Generic characters, those of the subfamily.

The figure (x, 16) of the dentition is copied from Troschel, and is from a quite young individual. The lingual ribbon is, in this genus, very minute compared with the size of the animal. Troschel was not able to detect any lateral teeth, but Macdonald, who only observed them towards the posterior extremity, records that they are very similar to those of Oliva. Other observers have not found a trace of lingual armature, and it is possibly only developed in the young animal. The animal of Harpa is variegated with beautiful colors. It crawls with vivacity. The front of the foot is crescent-shaped, and divided by deep lateral fissures from the posterior part. Unable to withdraw completely

within its shell, it is said, when irritated, to spontaneously detach a portion of this foot.

SILIA, Mayer, 1876. Ribs deflected, spire short, suture not deep. *H. Zitteli*, Mayer. Eocene.

HARPOPSIS, Mayer, 1876. (Buccinopsis, Bayle.) Shell smooth, the last whorl slightly angulated below the suture, very large and long; mouth small, lengthened; inner lip with thin callus; outer lip with slight posterior sinus. *H. stromboides*, Lam. Eocene; Paris basin.

FAMILY COLUMBELLIDÆ.

Shell oval, covered by an epidermis; spire more or less developed, generally short; aperture narrow, elongated, terminating in a very short anterior canal; columellar lip usually dentate; outer lip mostly thick, incurved in the middle and internally crenulated. Animal with a large, flattened head; the foot narrow, oval, elongated; the siphon scarcely longer than the canal of the shell. Operculum very small, lamellar, corneous. Dentition (x, 20).

COLUMBELLA, Lam., 1799.

Etym.—Diminutive of *columba*, a dove.

Syn.—Columbus, Montf., 1810. Peristera, Rafinesque, 1815. Pygmæa (Humphrey), Mörch, 1858.

Distr.—300 sp. Mostly subtropical; Atlantic Coast, U. S., West Indies, Mediterranean, India, China, Japan, Philippines, Australia, Polynesia, W. Coast of America. Fossil. Tertiary. *C. mercatoria*, Lam. (lvi, 78).

Shell strombiform or obovate, smooth or longitudinally or transversely ribbed; internal lip excavated in the middle, crenulated or denticulated in front; outer lip inflected and internally thickened and crenulated in the middle.

NITIDELLA, Swainson, 1840. Shell oval, smooth, spire elevated; aperture somewhat effuse below; columella with two small anterior plications, outer lip somewhat thickened. *C. nitida*, Lam. (lvi, 79).

ALIA, H. and A. Adams, 1853. Shell thin, smooth, spire moderate; aperture oval; inner lip finely crenulated, outer lip thick, not callous in the middle, striate within. *C. unifasciata*, Sowb. (lvi, 80).

MITRELLA, Risso, 1826. Shell mitriform, smooth, spire elevated; columella smooth or with a few anterior rugosities; outer lip smooth, or crenulated within. *C. lactea*, Duclos (lvi, 81).

ATILIA, H. and A. Adams, 1853. Shell fusiform, longitudinally plicate; spire elevated, sharp; last whorl suddenly narrowed in front. *C. suffusa*, Sowb. (lvi, 82).

ANACHIS, H. and A. Adams, 1853. Shell oval-fusiform, longitudinally ribbed; spire elevated; aperture narrow; columella

straight; outer lip nearly straight, crenulated within. *C. rugosa*, Sowb. (lvi, 83).

SEMINELLA, Pease, 1867. (Cytharopsis, Pease, 1867.) Shell small, fusiform, longitudinally costate; lip slightly emarginate above, lirate or denticulate within. *C. gracilis*, Pease (lvi, 84).

MITROPSIS, Pease, 1867. Shell fusiform, longitudinally more or less costate or plicate; aperture narrow; lip dentate, sinuate above; columella callous, plicate. Described as a group of Mitridæ, but appears to be more nearly related to the Columbellas. *C. fusiformis*, Pease (lvi, 95).

CONIDEA, Swainson, 1840. (Pyrene [Bolten], H. and A. Ad., 1853. Conella, Swainson, 1840.) Shell fusiform; inner lip reflected in front; outer lip crenulated within. *C. tringa*, Lam. (lvi, 85). *C. Philippinarum*, Reeve (lvi, 86).

META, Reeve, 1859. (Conella, H. and A. Adams, not Swainson, 1853.) Shell conoid, regularly attenuated towards the base, spire rather short, generally superficially channeled; aperture elongated, narrow, interior with revolving short ridges near the margin. 6 sp. So. Africa, W. Indies, Java, Philippines. *C. coniformis*, Sowb. (lvi, 94).

STROMBINA, Mörch, 1852. Shell fusiform, turriculated; spire sharp; whorls gibbous, nodulous; inner lip with a rather thick callus; outer lip thick, sometimes sinuous behind; anterior canal well-formed. *C. lanceolata*, Sowb. (lvi, 87).

AMYCLA, H. and A. Adams, 1853. Shell bucciniform, smooth, solid; aperture oval; columella smooth, truncated in front; outer lip arcuated, crenulated within. *C. dermestoidea*, Lam. (lvi, 88).

ASTYRIS, H. and A. Adams, 1853. Oval-fusiform, smooth or transversely striated; aperture oval; inner lip smooth, not callous; outer lip sinuous posteriorly, crenulated within. *C. Clausiliæforme*, Kiener (lvi, 89).

ÆSOPUS, Gould, 1860. Shell fusiform, gibbous, broadly truncate in front; aperture lunate, with a posterior callus on the body; columella smooth, vitreous; suture abnormally arcuate near the aperture. Animal white; foot emarginate in front, obtuse behind, bearing a corneous flabelliform operculum; head small; tentacles short, broad, eyes in the middle; siphon wide, short. Said to be intermediate between Columbella and Mitra. *Æ. Japonicus*, Gould.

ENGINA, Gray, 1839.

Distr.—45 sp. Tropical; Indo-Pacific, Polynesia, Panama, West Indies, etc. *E. trifasciata*, Reeve (lvi, 90).

Shell ovate-conic; spire sharp, with longitudinal nodulous ribs, decussated by revolving lines; aperture narrow, with several oblique plications in front; outer lip rather thick, inflected or callous in the middle, crenulated within.

PUSIOSTOMA, Swainson, 1840. Shell ovate; inner lip granulose;

outer lip greatly thickened in the middle and denticulated. *E. mendicaria*, Lam. (lvi, 91).

ALCIRA, H. Ad., 1860.

Distr.—*A. elegans*, Ad. South Africa.

Shell fusiform, thin; spire produced; whorls transversely striated; aperture ovate; columella truncate, with a single oblique fold anteriorly; outer lip thin, smooth internally, expanded at the hind-part, and with the anterior margin crenulated. Differs from other groups in its expanded lip, which is not thickened, and from most others in the columellar fold.

COLUMBELLINA, d'Orb., 1843.

Syn.—Zittelia, Gemmellaro, 1870.

Distr.—4 sp. Cretaceous; France, India. *C. ornata*, d'Orb. (lvi, 92). 1 sp. Recent.

Shell oval, thick, ventricose; aperture narrow, flexuous, narrowed in the middle, ending posteriorly in a prolonged lateral canal; outer lip much thickened and smooth within.

COLUMBELLARIA, Rolle, 1861.

Distr.—Upper Jura; Europe. *C. corallina*, Quenst. (liv, 35a).

Shell long-oval; body-whorl rather inflated; spire moderate; aperture wide below; outer lip rounded, not inflected in the middle, with strong revolving ribs within; columellar callus thin, showing the sculpture of the body-whorl.

AMPHISSA, H. and A. Ad., 1853.

Distr.—2 sp. West Coast of North America. *A. corrugata*, Rve. (lvi, 93).

Shell bucciniform, longitudinally ribbed; spire elevated; aperture rather wide, enlarging below and terminating in a wide anterior sinus; inner lip callous, plicate below; outer lip not thickened on the margin, plicate within.

FAMILY CANCELLARIIDÆ.

Shell ribbed, cancellated by revolving lines; mouth produced or angulated in front; columella plicated, outer lip ribbed within. Teeth shaped somewhat like those of the family Conidæ, arranged in two rows; the head does not seem to be elongated, the rostrum being rudimentary. There is no operculum.

CANCELLARIA, Lam.

Etym.—*Cancellatus*, cross-barred.

Distr.—70 sp. West Indies, Mediterranean, West Africa, India, China, W. Coast of tropical America. Fossil, 60 sp.

Commencing with the Upper Cretaceous. *C. cancellata*, Linn. (lvii, 96).

Shell oval, cancellated, reticulated or ribbed; last whorl ventricose; aperture oblong, canaliculated in front, canal short, sometimes recurved, columella with several large oblique plications.

The Cancellariæ are vegetable feeders, ranging from low-water to 40 fathoms.

TRIGONOSTOMA, Blainv. Shell conic-oval, widely umbilicated; whorls angular or babylonic, longitudinally ribbed; aperture triangular, angulated in front. *C. tuberculosa*, Sowb. (lvii, 97).

APHERA, H. and A. Adams. Shell oval, not umbilicated; columella and inner margin of aperture widely covered with callus. *C. tessellata*, Sowb. (lvii, 98).

EUCLIA, H. and A. Adams. Shell pyriform, not umbilicated; spire very short; whorls smooth; columella with large anterior plications. *C. solida*, Sowb. (lvii, 99).

MERICA, H. and A. Adams. Shell oval, spire sharp; whorls reticulated; aperture oblong, not channeled in front; columella with oblique plications; internal lip callous, exterior lip sharp. *C. elegans*, Sowb. (lvii, 100).

NARONA, H. and A. Adams. Shell oval, fusiform; spire elevated, sharp; whorls sharply ribbed; aperture oblong, canaliculated in front; the columella plicate, posterior rib the largest; outer lip crenulated. *C. clavatula*, Sowb. (lvii, 1).

MASSYLA, H. and A. Adams. Shell oval, turbinated, spire obtuse; whorls transversely striated; aperture reflected and channeled in front; columella truncated. *C. corrugata*, Hinds (lvii, 2).

TURBINOPSIS, Conr. Columella with a single very oblique fold near the basal margin. *C. Hilgardi*, Conr. (lvii, 3).

MOREA, Conrad. Short, elliptical; aperture much longer than the spire; columella reflexed, concave, with a prominent acute fold at the base. *M. cancellaria*, Conr. (lvii, 4). Cretaceous; Miss.

BABYLONELLA, Conr., 1865. Uncharacterized. 11 sp. Eocene. *C. elevata*, Lea. Claiborne, Ala.

ADMETE, Moller.

Distr.—*A. viridula*, Fabr. (lvii, 5).

Shell oval, thin, diaphanous, covered by a thin epidermis; spire sharp; last whorl ventricose; aperture oval, feebly channeled in front; columella arcuated, obliquely truncated, with rudimentary plications; outer lip sharp.

This small group represents Cancellaria in boreal seas in the same manner that Trophon replaces Murex and Bela does Mangelia.

ADMETOPSIS, Meek, 1872. Lower fold of columella most distinct, whilst the second fold is the most prominent in Admete; inner lip thickened throughout. 3 sp. Cretaceous; Utah. *A. gregaria*, Meek (lvii, 6).

[Genus PURPURINA, Lycett. This group of fossil shells, which I have placed in the Purpurinæ, is by others referred to Cancellariidæ.]

FAMILY TEREBRIDÆ.

The Terebras are known by their long, narrow, many-whorled shells, with small aperture, notched in front, and no true columellar plaits. The animal has a foot rounded in front, elongated behind; the head is large, with short, small tentacles; eyes at or near the tips of the tentacles, or wanting; between the tentacles extends a rather long cylindrical trunk. Operculum annular, horny, with apical nucleus.

TEREBRA, Lam.

Auger-shell.

Syn.—Terebraria, Raf. Acus, Humphrey. Dorsanum, Gray. Pyramitra, Cœlatura and Terebrifusus, Conr.

Distr.—About 200 sp. Mostly tropical; East Indies, West Coast America, etc. Fossil, 25 sp. Commencing with Eocene.

Shell elongated, turriculated, narrow, solid; whorls numerous, rather flattened, with superficially impressed sutures; aperture small, ovate, profoundly notched at the base; columella oblique.

SUBULA, Schum. Whorls smooth, aperture not produced. *T. maculata*, Linn. (lvii, 7).

ABRETIA, H. and A. Adams. Whorls longitudinally ribbed, aperture a little produced in front. *T. cerithina*, Lam. (lvii, 8).

HASTULA, H. and A. Adams. Whorls usually smooth, columella simple, a little produced in front. *T. strigillata*, Linn. (lvii, 9).

EURYTA, H. and A. Adams. Shell smooth or slightly ribbed, turriculated; last whorl somewhat ventricose; aperture large; columella produced in front, a little twisted. *T. aciculata*, Lam. (lvii, 10).

TEREBRA, Adanson. Shell much elongated, subulate; whorls very numerous, rather flat with a spiral band revolving beneath the sutures; aperture small, canaliculate. *T. cingulifera*, Lam. (lvii, 11).

MYURELLA, Hinds. Shell much elongated, subulate; whorls numerous, ribbed with a band of tubercles below the sutures. *T. nebulosa*, Sowb.

PUSIONELLA, Gray.

Syn.—Netrum, Phil.

Distr.—W. Africa, etc. *P. nifat*, Adans. (lvii, 12).

Shell fusiform or turriculated, oblong-oval, smooth; aperture oval-elongated, large, produced into a twisted canal in front; columella carinated, anteriorly twisted, with a small basal plication.

FAMILY PLEUROTOMIDÆ.

Shell fusiform, canaliculated, outer margin of aperture with a slit near the suture. Operculum corneous, annular, not always present. Animal with tentacles wide apart, the eyes at their outer bases.

PLEUROTOMA, Lam.

Etym.—*Pleura*, the side, and *toma*, a notch.

Syn.—Turris, Humph. Cochlespira, Conrad. Gemmula, Weink. Eucheilodon, Gabb.

Distr.—Over 500 sp. World-wide; low-water to 100 fms. Fossil, nearly as many. Cret.—. *P. babylonia*, Lam. (lvii, 13).

Shell turriculated, fusiform, terminated anteriorly by a straight, more or less long canal; aperture oval, columellar lip smooth, straight or sinuous; outer lip somewhat sinuous, with a posterior sinus.

SURCULA, H. and A. Adams. Turriculated, internal lip obsolete; canal long, narrow, slightly twisted. *P. nodifera*, Lam. (lvii, 14).

SURCULITES, Conrad. Shell with spire and body-volution nearly equal; the latter obconical, rectangular near the top, and flattened or concave above from the angle to the suture; sinus of lip above the angle of the whorls, shallow and broad. *S. annosa*, Conrad. Mr. Conrad never characterized it; but his type-species has the characters given above. It seems to be very near to Surcula but may probably be retained for a group of Tertiary species, with obconic body-volutions, usually referred to Pleurotoma, and forming a kind of transition toward the Conidæ (Meek).

GENOTA, H. and A. Adams. (Pseudotoma, Bellardi. Cryptoconus, Koen. Dolichotoma, Bellardi. Roualtia, Bell.?) Shell mitriform; whorls finely cancellated; aperture elongated, canal short; sinus profound. *P. Mitræformis*, Kiener (lvii, 15).

BRACHYTOMA, Swains. Shell strombiform; columellar lip rather thick; outer lip ascending and forming a sinus or narrow canal near the suture. *P. Stromboides*, Sowb. (lvii, 16).

CONOPLEURA, Hinds. Shell coniform; aperture narrow, sinuous; columellar lip callous; canal very short; outer lip sinuous, with a profound lateral sinus. *P. striata*, Hinds (lvii, 17).

DRILLIA, Gray. (Moniliopsis, Conrad.) Turriculated; aperture oval, oblique; canal short, twisted; columellar lip strongly callous above. Animal with approximate tentacles and eyes at their extremity. *P. gibbosa*, Kiener (lvii, 18).

CRASSISPIRA, Swains. Shell somewhat claviform, tuberculated;

scarcely any anterior canal; internal lip with a thick posterior callus; external lip thick within. *P. pulchra*, Gray (lvii, 19).

CLAVUS, Montf. Tuberculated or spiny; aperture rather large; internal lip smooth; outer lip produced below the sinus. *P. auriculifera*, Lam. (lvii, 20).

ANCISTROSYRINX, Dall. (Candelabrum, Dall.) Shell with the posterior surface of the whorls concave, with a broad deep sinus, bordered externally by a pectinated elevated frill, directed backwards. *P. elegans*, Dall. West Indies.

BELA, Gray. Shell oval, fusiform, thin; spire produced; canal short; sinus small, near the suture; columella flattened; operculum pointed at both ends. Northern. *P. turricula*, Montf. (lvii, 21).

BELOMITRA, Fischer, 1882. Shell like Bela, but with numerous plicæ on the columella. *B. paradoxa*, Fischer. Atlantic O., 627 mètres.

LACHESIS, Risso. (Anna and Nesæa, Risso. Atoma, Bellardi?) Turriculated, with convex whorls and mammillated apex; lip-sinus obsolete; operculum unguiform. Animal with converging tentacles, short siphon and short ovate foot. *P. minima*, Montf. (lvii, 22).

CLAVATULA, Lam. (Clavicantha, Swainson. Mesochilostoma, Seely?) Subfusiform; spire produced; whorls coronated; aperture oval; canal short; columella smooth, sinuous; lip-sinus profound. *P. imperialis*, Lam. (lvii, 23).

CLIONELLA, Gray. Shell fusiform, longitudinally ribbed; last whorl usually contracted in front; a more or less developed anterior canal; and posterior sinus. South Africa. A Melania-like shell, usually classed with Pirena, etc., and erroneously supposed to inhabit fresh waters. The eyes are placed near the tips of the tentacles, the foot is broad and very short. Operculum subelliptical with the nucleus near the middle of the inner side. Dentition, 1·1·1. *P. buccinoides*, Lam. (lviii, 24).

PERRONA, Schum., 1817. (Tomella, Swains.) Shell fusiform, subclaviform; spire more or less elevated, smooth or carinated; aperture somewhat narrow, terminating in a rather long canal; inner lip callous near the suture. *P. lineata*, Lam. (lviii, 25).

CLINURA, Bellardi. Ovately fusiform or turreted; sinus deep, arcuate; lip greatly produced anteriorly, aliform; columella contorted; canal rather long, oblique. *P. Calliope*, Brocchi (lviii, 27).

CLATHURELLA, Carp. (Defrancia, Millet. Homostoma, Bellardi.) Fusiform or turriculated; columellar lip without callosity except a small posterior tooth. No operculum. The cancellated surface, more ventricose form and more evident canal distinguish it from Mangelia, the emargination of the outer lip from Clavatula,

the texture and sculpture of the surface from Bela and Daphnella. *P. linearis*, Blainv. (lviii, 26).

ZAFRA, A. Adams. Acuminately oval, tumid in the middle; whorls longitudinally plicate, the last constricted at the base; aperture linear; inner lip effuse, its margin free; outer lip acute, subsinuate behind, subinflected in the middle. *P. Pupoidea*, H. Ad. (lviii, 28).

DAPHNELLA, Hinds. Shell fusiform, thin, fragile, usually striated; aperture elongated oval, canal very short. Small and elegant shells of slight thickness, distinguished from Defrancia by their elongated body-whorl, tenuity and sculpture. No operculum. *P. ornata*, Hinds (lviii, 29).

MITROMORPHA, A. Ad. Shell small, elongately fusiform; whorls flattened, with revolving liræ, and sometimes longitudinally plicate. Aperture narrow; columella straight, slightly transversely lirate; lip acute, smooth within, scarcely sinuated posteriorly. It is a Mitriform Daphnella, of small size, with lirate whorls. *Distr.*—California, Japan. *M. gracilis*, Carp. (lviii, 30).

CITHARA, Schum. (Mangelia, Reeve [not Leach]. Otocheilus, Conr. Cytharella, Monts.) Fusiform, polished, longitudinally ribbed; aperture linear, truncated in front, slightly notched behind; outer lip margined, denticulated within; inner lip frequently finely striated. The animal has the mantle-margin slightly dilated on the right side. No operculum. Over 50 species occur at the Philippine Islands. *P. Stromboides*, Reeve (lviii, 31).

CYTHAROPSIS, A. Ad. Differs from Cithara in having a subproduced recurved canal and cancellated surface. *C. cancellata*, A. Ad. Japan.

GLYPHOSTOMA, Gabb. Like Cithara, having numerous columellar plaits in adult specimens, but with a lengthened canal and deep narrow posterior lip-sinus. *P. dentifera*, Gabb (lviii, 32). A number of recent exotic species have been referred to this group.

MANGELIA, Leach. (Bellaspira, Conr.) Fusiform, mostly longitudinally ribbed; spire elongated, turriculated, acuminated; canal short, more or less truncated; columella smooth; sinus near the suture. No operculum. *P. ponderosa*, Reeve (lviii, 33).

TYPHLOMANGELIA, M. Sars. Narrow and elongate, spire produced conic, whorls many, nodosely angulate in the middle, aperture narrow, with distinct sinus, the outer lip simple, arcuate and inflexed in the middle. Operculum pyriform. Animal without eyes. *P. nivalis*, Lov. (lviii, 34).

SPIROTROPIS, Sars. Shell elongated, turreted, spire produced, the obtuse apex mammilliform, whorls numerous, carinated in the middle, aperture narrow, oblique, with a short canal, sinus deep,

remote from the suture. Operculum ovate-pyriform. *P. carinata*, Phil. (lviii, 35).

RAPHITOMA, Bellardi. Fusiform, turriculated, spirally sculptured; canal short; sinus very small. 22 sp. occur on the Dalmatian coast alone, but the cancellated species may be more properly referred to Clathurella. There are a number of Italian tertiary species. *P. ringens*, Bellardi (lviii, 36).

TARANIS, Jeffreys. Shell minute, cancellated, whorls angulated, slightly exserted at base, aperture pyriform, outer lip thin, simple, sinus obsolete, canal short. No operculum. *T. Mörchii*, Malm. (lviii, 37).

THESBIA, Jeffreys. Shell thin, rather smooth, somewhat tumid, with a short spire and irregularly contorted apex, aperture slightly expanded, the outer lip thin, with distinct sinus, canal short, columella simple. No operculum. *T. nana*, Lovén (lviii, 38).

PLEUROTOMELLA, Verrill. Shell somewhat turreted, apical whorls smooth, others shouldered and ribbed, but with a smooth concave band below the sutures; outer lip very thin, sharp, with a wide, deep sinus above. No operculum. Animal without eyes. *P. Packardii*, Verrill. N. Engl. Coast.

BORSONIA, Bellardi. (Oligotoma, Bell.) Shell fusiform, with a plication upon the middle of the columella. Miocene; Europe. *P. prima*, Bellardi (lviii, 39).

CORDIERA, Roualt. (Scobinella, Conr. Aphanitoma, Bellardi.) Shell fusiform, with two columellar plaits. This and the last subgenus should probably be merged in one. Eocene, Miocene; Eur., America. *P. Pyrenaica*, Roualt. (lviii, 40).

HALIA, Risso.

Etym.—*Halios*, marine. *Syn.*—Priamus, Beck.

Distr.—*H. Priamus*, Lam. (lviii, 41). Spain.

Shell oblong-ovate, ventricose, thin, polished; spire produced, apex obtuse, papillary; columella curved, truncate anteriorly; outer lip simple, thin, effuse, slightly sinuated near the fore-part. No operculum. A single species occurs very rarely in collections, and was supposed to inhabit the Western Coast of Spain; it occurs in the Italian tertiary. Dr. P. Fischer has examined the animal of this singular shell, and finds it to be related to Pleurotoma. Known to science for more than a century, the habitat of Halia has remained unknown until quite recently; it is now certain that it lives off Cadiz, Spain.

FAMILY CONIDÆ.

Teeth subulate, in two series, on a tubular prolongation of the retractile proboscis, with a bundle of sharp, subulate teeth at the extremity. Head with a produced tubular veil; tentacles subulate, eyes on bulgings or slight truncatures on the outer side of

the tentacles. Mantle enclosed, with an elongate siphon at the fore-part. Foot simple, undivided, oblong, with a conspicuous aquiferous pore on the middle of the under surface.

Operculum, when present, rather small, ovate or unguiform, with apical nucleus.

The great family of Cones, characterized by the peculiar structure of the mouth, no less than by the similarity in the form of the shell, are principally inhabitants of the equatorial seas. Haunting the holes and fissures of rocks, and the labyrinths of coral-reefs, they lead a predatory life, boring into the shells of other mollusks and sucking the juices from their bodies. In the Asiatic region the species seem greatly to predominate, whilst but two or three inhabit European seas, and about fifty the tropical shores of America. Low-water to 30 or 40 fathoms.

The teeth of Conus (x, 5) serve for attack or defense. Mr. Arthur Adams (*Voy. Samarang*, ii, 356) relates that, at the Moluccas, Sir Edward Belcher was bitten by a Cone, which suddenly exserted its proboscis as he took it out of the water with his hand, and he compares the sensation he experienced to that produced by the burning of phosphorus under the skin. The bite leaves a small, deep, triangular mark, which is succeeded by a watery vesicle.

CONUS, Linn.

Distr.—About 300 recent sp., and nearly 100 fossil forms. Cretaceous—. *C. marmoreus*, Linn. (lviii, 42).

Shell thick, obconic, whorls enrolled upon themselves, the spire short, or not elevated, smooth or tuberculated; aperture elongated, narrow, the margins parallel, truncated at the base; the outer lip with a slight sutural sinus. The typical group is limited by H. and A. Adams to species with regularly conic shell, short or depressed spire and coronated whorls.

STEPHANOCONUS, Mörch. Spire elevated, sutures concave. *C. cedonulli*, Linn. (lix, 44).

PUNCTICULIS, Swains. Spire slightly elevated, coronated, last whorl ventricose. *C. pulicarius*, Brug. (lviii, 43).

CORONAXIS, Swains. Shell a little turbinated, spire elevated, convex, coronated. *C. vermiculatus*, Lam. (lviii, 45).

CYLINDRELLA, Swains. Cylindrically conic, with revolving striæ; spire elevated, concave. *C. sulcatus*, Brug. (lviii, 46).

NUBECULA, Klein. (Tuliparia, Swains.) Shell light, subcylindrical; spire short, but pointed at the summit, whorls slightly coronated; aperture effuse, emarginate in front, columella smooth; outer lip with a wide but not deep notch at the suture. M. Quoy observes of this group that the foot is very large, and not entirely retractile within the shell, as in other members of the family; the anterior marginal groove conceals a large pore, the aperture of an aquiferous canal; the tubular veil is

fringed at the margin, and can sufficiently dilate itself to admit the tip of the little finger into the orifice. Operculum small, unguiculate, slightly curved. *C. tulipa*, Linn. (lviii, 47).

DENDROCONUS, Swains. Shell thick, convex-conic; spire truncated, not coronated. *C. figulinus*, Linn. (lix, 51).

LITHOCONUS, Mörch. Conical, carinated at the suture. *C. literatus*, Linn. (lix, 52).

LEPTOCONUS, Swains. Conical, sometimes striated; spire elevated, sharp, concave. The foot of *C. miles*, says Quoy, is very narrow, and the operculum longer than usual; the tentacles are slender and the veil pointed at the extremity. *C. nobilis*, Linn. (lix, 53).

RHIZOCONUS, Mörch. Shell conical, smooth; spire short but sharp, last whorl carinated at the suture. *C. generalis*, Linn. (lix, 54).

CHELYCONUS, Mörch. Spire elevated, last whorl convex near the suture. *C. spectrum*, Linn. (lviii, 48).

CYLINDER, Montf. (Textilia, Swains.) Shell conic-cylindrical, smooth; spire elevated, sharp; last whorl slightly ventricose. *C. textile*, Linn. (lviii, 49).

HERMES, Montf. (Theliconus, Swain.) Subcylindrical, with revolving ribs; spire elevated, obtuse, convex. *C. tendineus*, Brug. lix, 55).

CONORBIS, Swains. Spire much elevated; outer lip sinuous, forming an oblique posterior sinus. Connects Conus with Pleurotoma. Eocene; England, France. *C. dormitor*, Sol. (lviii, 50).

The above divisions are partly recognized as genera, partly as subgenera, by H. and A. Adams; but they possess little value, as their characters merge one into another. Weinkauff, who has recently monographed the genus, casts aside these divisions, and in their stead proposes sections, named after certain specific types, as follows:

1. Marmorei. (Typical Conus.) *C. marmoreus*, Linn.
2. Literati. (Lithoconus in part.) *C. literatus*, Linn.
3. Figulini. (Dendroconus.) *C. figulinus*, Linn.
4. Arenati. (Puncticulus.) *C. arenatus*, Hwass.
5. Mures. (Coronaxis.) *C. mus*, Hwass.
6. Varii. *C. varius*, Linn.
7. Ammirales. (Leptoconus and Rhizoconus in part.) *C. ammiralis*, Linn.
8. Capitanei. (Rhizoconus in part.) *C. capitaneus*, Linn.
9. Virgines. (Lithoconus in part.) *C. virgo*, Linn.
10. Dauci. (Rhizoconus in part.) *C. daucus*, Hwass.
11. Magi. (Phasmoconus and Pianoconus, Mörch.) *C. magus*, Linn.
12. Achatini. (Chelyconus.) *C. achatinus*, Chemn.

13. Asperi. (Hermes and Cylinder in part.) *C. asper*, Lam.
14. Terebri. (Hermes.) *C. terebra*, Born.
15. Bulbi. *C. bulbus*, Reeve.
16. Tulipæ. (Nubecula, and Phasmoconus in part.) *C. tulipa*, Linn.
17. Texti. (Cylinder.) *C. textile*, Linn.

FAMILY STROMBIDÆ.

Shell with an expanded lip, deeply notched near the canal. Operculum claw-shaped, serrated on the outer edge.

Animal furnished with large eyes, placed on thick pedicels; tentacles slender, rising from the middle of the eye-pedicels. Foot narrow, ill-adapted for creeping. Lingual teeth single; uncini, three on each side (xi, 28).

Strombus gigas (lix, 56) is occasionally used as an article of diet; it sometimes produces pearls; and the layers composing the shell being of different colors, it is extensively used in carving cameos. It is also ground to powder for the manufacture of the finer kinds of porcelain, 300,000 having been imported into Liverpool from the Bahamas Islands in one year, and used chiefly for this purpose.

The perfect development of the large, fine, pedunculated eyes of Strombus, together with its very elongated, powerful, muscular body and foot, and claw-shaped, stout, jagged, horny operculum, constitute it one of the most active and intelligent of mollusks. It is, in fact, a most sprightly and energetic animal, making extraordinary leaps in its endeavors to escape from confinement, planting firmly its powerful narrow operculum against any resisting surface, insinuating it under the edge of its shell, and, by a vigorous effort, throwing itself forwards, carrying its great heavy shell with it, and rolling along in a series of jumps in a most singular and grotesque manner.—A. ADAMS, *Voy. Samarang*, ii, 493.

STROMBUS, Linn.

Etym.—*Strombos*, a top. *Syn.*—Pyramis, Bolt.

Distr.—66 sp. W. Indies, Medit., Red Sea, Ind. O., China, N. Zeal., Polynesia, W. tropical Am. Occurring on reefs, at low-water, and to 10 fms. Fossil, a few species. Cretaceous—. *S. gigas*, Linn. (lix, 56, 57).

Shell ovate, turreted or subfusiform; aperture narrow, elongate, emarginate or with a short canal in front, canaliculated posteriorly; outer lip often lobed and with a deep notch in front near the canal. In the young the lip is not expanded, and the shell looks like a Conus.

MONODACTYLUS (Klein). H. and A. Adams. Outer lip with a posterior much produced lobe. *S. Pacificus*, Swains. (lix, 58).

GALLINULA (Klein), H. and A. Adams. Inner lip not spread widely over the body-whorl; outer lip somewhat restricted; having a long posterior canal, ascending the spire. *S. succinctus*, Linn. (lix, 59).

CANARIUM, Schum., 1817. (Strombidea, Swains.) Inner lip restricted, outer lip not dilated, posterior canal short or obsolete. *S. Luhuanus*, Linn. (lix, 60).

EUPROTOMUS, Gill. Lip widely expanded, ascending the spire to its apex, the margins subdigitate, sinus of lip anterior. Most nearly related to Pterocera, among the Strombs. *S. laciniatus*, Chemn. (lix, 61).

ONCOMA, Mayer, 1876. Spire short; whorls convex, keeled or tuberculate; the last very large, keeled behind; mouth long, with short anterior canal; outer lip wing-like, entire. 8 sp. Eocene and Oligocene. *S. Fortisi*, Brongt.

PTERODONTA, d'Orbigny.

Distr.—Fossil, 8 sp. Chalk; France. *P. inflata*, d'Orbigny (lxxxviii, 56).

Shell oblong, ventricose, spire elongated; aperture oval, lip slightly expanded, notched in front, and with a tooth-like ridge internally, remote from the margin.

PUGNELLUS, Conr.

Distr.—Fossil. Cretaceous only. *P. hamulus*, Gabb (lx, 71, 72).

Shell fusiform in the young state; in the adult aperture narrow, outer lip developed into a massive lobe, notched above and below; canal produced and incurved; the whole shell enveloped in a more or less heavy incrustation, a prolongation of the deposit on the inner lip.

GYMNARUS, Gabb. Outer lip less heavy and produced posteriorly in a hook; anterior canal slightly produced and straight; incrustation not covering the entire shell, the back being exposed. A single species from the Chico group (Cret.) of California. *P. manubriatus*, Gabb (lx, 73).

PTEROCERA, Lam.

Etym.—*Pteron*, a wing, and *ceras*, a horn.

Syn.—Harpago, Millipes and Heptadactylus, Klein.

Distr.—10 recent sp. Indian Ocean and eastern Pacific. Fossil. Jurassic, Cret.—. *P. lambis*, Linn. (lix, 62).

Outer edge of mantle digitate. Operculum as in Strombus. Shell ovate, spire more or less elevated; aperture elongate, outer lip digitate, with a long, straight or curved anterior canal, and a shorter or long posterior canal, ascending and surpassing the spire.

When young, the outer lip of the shell is simple, resembling that of Strombus; the claws are gradually formed with the growth of the shell and are at first open canals, which afterwards become closed and solid.

Messrs. Adams adopted two of Klein's names for subgenera having no good characters; these may be advantageously replaced by Prof. Theo. Gill's arrangement, as follows:

PTEROCERA, Lam. (restricted). Anterior canal straight or curved to the right, posterior canal ascending the spire.

HARPAGO (Klein), H. and A. Adams. Anterior and posterior canals both curved to the left, the latter at first crossing transversely to the length of the shell. *P. rugosa*, Sowb. (lix, 63).

PHYLLOCHEILUS, Gabb, 1868. (Malaptera, Piette, 1879.) Outer lip with no digitations, or small ones only; inner lip expanded as a thin plate over the front of the body-whorl, and sometimes projecting beyond it laterally; both outer and inner lips deeply notched anteriorly, near the canal. *P. speciosa*, d'Orb. (lx, 74).

ROSTELLARIA, Lam.

Etym.—*Rostellum*, a little beak.

Syn.—Fusus, Humphr. Gladius, Klein. Platyoptera, Conr. Rostellum, Montf.

Distr.—8 sp. Red Sea, India, Borneo, China. Range, 30 fms. *R. curta*, Sowb. (lix, 64).

Animal with digitated mantle-margin. Operculum not serrated. Shell fusiform with elevated spire, whorls smooth; aperture continued into a long, straight or slightly curved anterior canal; outer lip slightly thickened on the margin and denticulated. The (restricted) Rostellarias belong to the present epoch, or extend at most only into the more recent tertiaries.

HIPPOCHRENES, Montf. Posterior canal extending up the spire to near the apex, or curving behind it; lip much expanded. An Eocene group; Europe and America. *R. macroptera*, Lam. (lx, 75).

RIMELLA, Agassiz. Whorls cancellated, posterior canal running up the spire, anterior canal short. Cretaceous—recent. *R. crispata*, Sowb. (lix, 65).

LEIORHINUS, Gabb. Fusiform, spire about as long as the aperture; columella slightly twisted and with a fold or thickening on the edge, extending to the end of the canal; inner lip thickened and with one tooth near the suture; outer lip thickened posterior to the edge; edge thin and incurved, with a small emargination posteriorly, and opposite to the tooth on the inner lip; no anterior sinus; surface smooth or only marked by lines of growth. *P. proruta*, Conrad (lx, 92). Eocene; Ala. Gabb placed it in Pleurotomidæ, but it was subsequently referred here by Conrad and Meek.

ISOPLEURA, Meek. Longitudinally ribbed, aperture narrow, notched in front, outer lip simple, no posterior canal. Cretaceous. *R. curvilirata*, Conr. (lx, 76).

CYCLOMOLOPS, Gabb. Smooth, without anterior canal, posterior canal long, running up the spire, columellar lip with a thick callus which, continuing around the anterior end of the aperture, forms a thickened margin to the outer lip. *R. lævigata*, Mellv. (lx, 77).

ORTHAULAX, Gabb. Shell rounded-fusiform, canal moderate, straight and regularly tapering; adult shell enveloped over the whole spire by an extension of the inner-lip callus; posterior canal fissure-like, formed by the continued edge of the outer lip and running directly to the apex; outer lip apparently sharp and simple, anterior notch oblique and broad. *P. inornata*, Gabb. Tertiary; West Indies.

CALYPTRAPHORUS, Conr. Anterior canal long and straight; posterior canal long, appressed to the spire and arching on the back; outer lip moderate, rounded and thickened on the margin by a smooth border; young shell showing all the volutions, which are hidden in the adult by a polished incrustation covering the entire surface, and in some species bearing tubercles. Eocene; U. S. Cretaceous; India. *R. trinodiferus*, Conr. (lx, 78).

SPINIGERA, d'Orb.

Distr.—5 sp. Fossil, in the Oolite of Europe. *S. longispina*, Desl. (lx, 79). *S. spinosa*, Munst. (lx, 80).

Shell elongated, slender, fusiform, with a long, straight anterior canal; each volution bearing one or two varices, those of successive whorls being arranged continuously as in Ranella, and bearing each a long, transverse spine.

TEREBELLUM, Lam.

Etym.—Diminutive of *terebra*, an auger.

Syn.—Seraphs, Montf.

Distr.—*T. subulatum*, Lam. (lix, 66). China, Philippines. Fossil, 8 sp. Eocene—; London, Paris.

Animal with eyes on the ends of peduncles, no tentacles, foot anteriorly small and rudimentary. Operculum narrow, denticulate. Shell subulate, spire slightly produced or blunt; aperture narrow, notched in front; outer lip simple, sharp; inner lip more or less incrusted, the columella straight and truncate.

The Terebellum inhabits deep water. In progressing, it rolls its shell over and over, performing a series of irregular jumps; when first taken from the water, it will even leap several inches from the ground. It is extremely shy and sensitive in its habits, poising the shell in a vertical position, and protruding the longer telescope eye (for, singularly enough, one eye-pedicel

is longer than the other) from the notch in front of the shell; it will thus remain perfectly immovable until assured of security, when it begins to roll over and examine the ground with its rostrum.

TEREBELLOPSIS, Leymerie. Spire very long. A single French nummulitic fossil. *T. Braunii*, Leym. (lx, 81).

APORRHAIS, Dillw.

Etym.—Spout-shell, from *aporrheo*, to flow away.

Syn.—Chenopus, Phil.

Distr. — 4 recent sp. W. Africa, Mediterranean, boreal Europe and America. Range, 100 fathoms. Fossil. Lias—. *A. pes-pelecani*, Lam. (lix, 67).

Animal with elongated, tapering muzzle; tentacles subulate, with eyes at their outer bases; mantle with outer side expanded, lobed, and with a rudimentary siphon in front, bending to the right; foot small, oblong, simple. Operculum lamellar, ovate or pointed, nucleus small, apical.

Shell fusiform, turreted or oblong-ovate, with a short canal in front and a posterior canal running up the spire; outer lip of the adult expanded and 2-3 digitated, the digitations forming carinæ on the back of the shell. The rostriform head, sessile eyes and rudimentary siphon, together with certain peculiarities of the shell, have been supposed to indicate strong affinities with the Cerithiidæ; but that these mollusks are most closely related to the Strombs (which they certainly resemble in dentition) is scarcely doubtful.

Chiropteron semilunare is probably a larval Aporrhais.

On the authority for the generic name, see Gabb, *Am. Jour. Conch.*, iv, 143.

GONIOCHEILA, Gabb. (Alipes, Conr.) Shell with posterior canal extending about half-way up the spire, and not free at the end; expanded outer lip with only one projecting angular process, but bearing one or more external carinæ in front of this that do not terminate in marginal digitations; canal short and strongly incurved; inner lip thick. *A. liratus*, Conr. (lx, 82).

ARRHOGES, Gabb. (Monocuphus, Piette. Perissoptera, in part, Tate.) Shell with expanded lip, merely terminating in a single posterior obtuse lobe-like extension, and having its anterior sinus nearly or quite obsolete; posterior canal *very* short; anterior canal also short and obtuse. *Rostellaria occidentalis*, Beck (lix, 68), the only species (recent).

CYPHOSOLENUS, Piette, 1876. Shell turreted, fusiform, with longitudinal ribs and numerous revolving riblets; last whorl with a pair of tuberculate carinæ, forming two digitations; wing subpalmate, tridactylous, not sinuous, the digitations long;

canal produced anteriorly into a long digitation. *C. tetrac* d'Orb. Several species. Jurassic; France.

ANCHURA, Conr.

Syn.—Drepanocheilus, Meek. Perissoptera, Tate. Mo dactyles, Piette.

Distr.—Jur., Cret.; America. Species numerous. *A. abrup* Conr. (lx, 83). *A. falciformis*, Gabb (lx, 84).

Fusiform, anterior canal straight, more or less produced; posterior canal; outer lip produced postero-laterally into a lo or process, which is scythe-shaped, or falcate.

The original Anchura had a falcate process, whilst that Meek's subgenus is single to the end and scythe-shaped, but series of species show every gradation between the two.

HELICAULAX, Gabb, 1868.

Distr.—Cret.; Europe. *H. ornata*, d'Orb. (lx, 85).

Shell like Anchura, but with a long posterior canal ascendi the spire to near the apex, usually deflected near its extremit inner lip usually heavily incrusted, the callus sometimes extendi some distance up the spire.

DIMORPHOSOMA, Gardner, 1875. Like Helicaulax, but posteri canal short; a single small, sickle-form wing, only attached the last or last two whorls. *H. calcarata*, Sowb.

LISPODESTHES, White, 1875.

Distr.—2 sp. Cretaceous; N. America. *L. linguifera*, Whi (lx, 86).

Shell fusiform; anterior canal straight or slightly curved, a more or less produced; posterior canal extending nearly or qui the whole length of the spire, from near the apex of which may be a little deflected; aperture winged; wing rather larg bearing two processes; the posterior process spine-like or fal form; the anterior process either in the form of a lobe or tong shaped; inner lip and spire covered with callus.

Related to Helicaulax, Gabb, of which it may be only subgenus.

PEREIRÆA, Crosse.

Distr.—*P. Gervaisii*, Vezian (lx, 87). Tertiary of Portug Whorls all coronated with spiny tubercles except the la where they are replaced by a carina. Lip prolonged in fro thick, with two digitations. Columella and ventral portion the shell covered with enamel.

DICROLOMA, Gabb.

Syn.—Hemicaudes, Piette. Tridactylus, Gardner.

Distr.—Lias and Oolite; Europe. *D. Lorieri*, d'Orb. (lx, 88

Elongate, fusiform, anterior canal long and straight, or curved; no posterior canal; outer lip with two long, slender, digitate processes.

TESSAROLAX, Gabb.

Distr.—Cret.; Am., Eur. *T. bicarinata*, d'Orb. (lx, 89).

Shell subfusiform, spire elevated; the greater part or whole of spire and body-whorl covered by an extension of the inner lip in the adult; anterior canal long, curved or straight; posterior canal long, running up the spire and extending beyond it; outer lip carrying two long, slender digitate processes; the incrustation of the adult shells carries one or two prominent bosses or tubercles on the body-whorl.

PTEROCERELLA, Meek. Shell small, thin; whorls few, rounded, smooth or subangulated; last one not much enlarged. Lip greatly extended, and ascending the spire, trilobate—the middle lobe much larger and more produced than the others, carinated on the outer side. *T. Tippana*, Conrad (lx, 90). Cretaceous.

ALARIA, Morris and Lycett, 1850.

Syn.—Alaria, sections Varicifer and Longicaudes, Piette.

Distr.—Jurassic; Eur., India. *A. armata*, Morris and Lycett (lx, 91).

Shell fusiform, spire elevated; anterior canal more or less produced, straight or curved; no posterior canal; outer lip digitate, formed at one or more stages previous to the adult age, and left behind by the growth of the shell, producing varices or tubular spines; inner lip thin.

The above description defines the genus as restricted by Gabb.

DIARTHEMA, Piette. Shell with continuous varices; a wing-like varix opposite the mouth. Lower Oolite; France. *A. paradoxa*, Desh.

CUPHOTIPHER, Piette. The wing-like varix with a strong, laterally compressed tubercle, sometimes developing a posterior finger. *D. ranelloides*, Piette. Jura.

DIEMPTERUS, Piette, 1876. Shell fusiform, winged, with straight anterior canal; whorls with spines or varices; wing entire or digitate; last whorl with a strong varix opposite the wing, indicating the position of a former mouth. *D. goniata*, Heb. Callovien.

HARPAGODES, Gill, 1869.

Distr.—Cret. and Jur.; Europe. *H. pelagi*, d'Orb. (lx, 93).

Shell obconic or ovate-conoid, spire moderate, canal produced into a long digitation boldly recurved towards the left, labrum much alated and produced into spiniform digitations. Whorls convex or flat between the angle and suture, spirally ribbed, with larger rib-like, angular, median, and anterior fascioles (and sometimes post-angular), each emitting long spiniform digitations;

and with a sutural canaliculate digitation accumbent on the spire, continued and recurved backwards.

CERATOSIPHON, Gill, 1870.

Syn.—Ornithopus (in part), Gardner, 1875.

Distr.—Cret.; France. *C. Moreausiana*, d'Orb. (lx, 94).

Shell fusiconic, with the spire considerably elevated, the canal produced into a long digitation recurved towards the left, and the labrum much alated and produced into spiniform digitations. Whorls concave or flat between the angle and suture, spirally striated, and with rib-like angular, median and anterior fascioles, of which the two former, at least, emit spiniform digitations, the suture emitting a digitiform canal accumbent on the spire and directed backwards.

Distinguished by the elongated hamiform siphonal canal and the posterior canal co-ordinated with the *facies* of Aporrhais.

STRUTHIOLARIA, Lam.

Etym.—*Struthio*, an ostrich (-foot), from the form of the aperture.

Distr.—5 sp. Australia, New Zealand. *S. nodulosa*, Mart. (lix, 69). Fossil. Tertiary; N. Zeal., So. Ama.

Animal with outer mantle-margin simple, tentacles cylindrical, eye-pedicels short, adnate with the tentacles externally, foot broad and short. Operculum claw-shaped, with an apical projection. Shell turreted, whorls angular, aperture truncated in front, columella very oblique; outer lip prominent in the middle, reflected and thickened in the adult, inner lip callous, expanded.

PELICARIA, Gray. Shell elevated, turreted; spire of adult covered with enamel; aperture ovate; outer lip sinuous, thin, inner lip incrusted. A single species, *S. scutulata*, Mart. (lix, 70).

LOXOTREMA, Gabb. Shell elongate, turreted, spire high; aperture with a very short canal in front; outer lip retreating above, sinuous below; inner lip heavily incrusted. *S. turrita*, Gabb (lx, 95).

DOLOPHANES, Gabb. Elongate-oval, spire elevated; umbilicus imperforate; aperture semi-oval, inner lip acute, sinuous, anteriorly terminating in a short, not emarginate canal. *S. melanoides*, Gabb. Tertiary; West Indies.

FAMILY CYPRÆIDÆ.

Shell convolute, enameled; spire concealed by the last whorl, which is very large; aperture narrow, channeled at each end; outer lip (of adult) thickened, inflected. No operculum.

Animal with a broad foot, truncated in front; mantle expanded on each side, forming lobes, which meet over the back of the shell; these lobes are usually ornamented with tentacular fila-

ments; eyes on the middle of the tentacles or near their base; branchial plume single. Lingual ribbon long; rachis 1-toothed; uncini 3 (xi, 30).

CYPRÆA, Linn.

Cowry. *Etym.*—*Cypris*, a name of Venus.

Syn.—Porcellana, Rumph. Naria, Gray. Cypræorbis and Sulcocypræa, Conr. Peribolus, Adans.

Distr.—200 sp. Tropical and subtropical, on reefs and under rocks at low-water. Fossil, 100 sp. Cretaceous—; Europe, India, United States. *C. argus*, Linn. (lxi, 96). *C. exanthema*, Linn., young (lxi, 97).

Shell ventricose, convolute, covered with shining enamel; spire concealed; aperture long and narrow, with a short canal at each end; inner lip crenulated; outer lip inflected and crenulated.

The young shell has a thin and sharp outer lip, a prominent spire, and is covered with a thin epidermis. When full-grown the mantle-lobes expand on each side, and deposit a shining enamel over the whole shell, by which the spire is entirely concealed. There is usually a line of paler color, which indicates where the mantle-lobes met. *Cypræa annulus* is used by the Asiatic Islanders to adorn their dress, to weight their fishing-nets, and for barter. Specimens of it were found by Dr. Layard in the ruins of Nimroud. The money-cowry (*C. moneta*, lxi, 1) is also a native of the Pacific and Eastern seas; many tons weight of this little shell are annually imported into England, and again exported for barter with the native tribes of Western Africa; in the year 1848 sixty tons of the money-cowry were imported into Liverpool. Mr. Adams observed the pteropodous fry of *C. annulus*, at Singapore, adhering in masses to the mantle of the parent, or swimming in rapid gyrations, or with abrupt jerking movements by means of their cephalic fins.

Bruguiere stated, and Lamarck believed, that as the animal increased in size, it was obliged to leave its shell, in order to make a new and more capacious one. The notion of Sowerby and Reeve that Cypræa can absorb the outer lip and form another is not less fanciful. Such hypotheses were founded on the circumstance that full-grown shells are often smaller than half-grown specimens; but the difference of size in individuals of the present family is paralleled in many others.

In their habits the cowries are shy and crawl slowly; as they glide along among the coral reefs, with the lateral lobes of their mantle adorned with showy colors, they present to the eye of the naturalist objects of singular interest and beauty.

LUPONIA, Gray. (Cypræidia, Swains.) Comprises the pyriform species, having usually a few strong irregular plaits at the fore-

part of the columella. *C. lynx*, Linn. (lxi, 98). *C. tigris*, Li
(lxi, 99).

ARICIA, Gray. Characterized by the flattened base and thi
ened callous margins of the last whorl, and gibbous back.
Arabica, Linn. (lxi, 100). *C. moneta*, Linn. (lxi, 1).

CYPRÆOVULA, Gray. Pyriform, oval, ventricose; surface c
ered with revolving striæ. 2 sp. Cape of Good Hope.
Capensis, Gray (lxi, 4, 5).

GASKOINIA, Roberts. (Pseudocassis, Pictet.) Form of Lupon
aperture without teeth. One recent species; and a cast. C
taceous; Europe. *C. edentula*, Sowb. (lxi, 2, 3).

Troschel adopts the genera Cypræa and Aricia, and propo
the following subgeneric groups, which have not been adopt
because the species cited as typical may be mostly connected
other species having intermediate characters.

Cypræa—
Subgenus Talparia. *C. talpa*, Linn.
" Tigris. *C. tigris*, Linn.
" Lyncina. *C. lynx*, Linn.
" Mauritia. *C. Mauritiana*, Linn.

Aricia—
Subgenus Erronea. *C. errones*, Linn.
" Erosaria. *C. erosa*, Linn.
" Monetaria. *C. moneta*, Linn.

TRIVIA, Gray. (Coccinella, Leach.) Small shells with str
extending over the back, where they are frequently interrupt
by an impressed dorsal sulcus. 45 species, one of which inhab
the temperate seas of Northern Europe. *C. quadripuncta*
Gray (lxi, 6, 7). "It is surprising to see with what facility t
expanded animal of Trivia withdraws itself—foot, mantle, he
and tube—through the narrow opening of the shell (Clar
MS.). Like *Buccinum undatum* it continually discharges
immense quantity of clear slime. Couch says that it often g
into crab-pots; so that it seems to be fond of all kinds of anin
food."—JEFFREYS.

PUSTULARIA, Swainson. Back with rows of pustules proceedi
from the dorsal sulcus, both lips ribbed clear across. *C. pus
lata*, Lam. (lxi, 8, 9).

EPONA, H. and A. Adams. Globular, produced at the extre
ities; lips more less striated across. *C. cicercula*, Linn. (l
10, 11).

[ERATO, Risso.

This group, which I have placed in Marginellidæ (p. 172), m
belong here; it is somewhat closely related to Trivia, throu
its sculptured species, and (apparently) in dentition.]

OVULUM, Brug.

Syn.—Amphiperas, Gronov. Simnia, Risso.

Distr.—75 sp. Tropical and subtropical. Fossil. Tertiary—. *O. pyriformis*, Sowb. (lxi, 12, 13).

Shell ventricose, convolute, attenuated and subacuminated at both ends; outer lip of adult thickened and inflected.

These shells are not ornamented with the rich and varied colors of the cowries, having but little pattern-painting; they are at once distinguished from them by the attenuated and frequently produced ends.

Simnia was proposed for a few species, with sharp aperture-margin, which have proved to be the young of typical Ovulæ.

CALPURNUS, Montf. (Cypræella, Swains.) Cypræiform, gibbous, with a small tubercle at each extremity. *O. verrucosum*, Linn. (lxi, 14, 15).

CYPHOMA, Bolten (Carinea, Swains.) Shell with a transverse dorsal rib; inner lip smooth, outer lip very slightly crenulated. *C. gibbosum*, Linn. (lxi, 16, 17).

VOLVA, Bolten. (Birostra, Swains. Radius, Montf.) Shell ventricose in the middle, both extremities prolonged into canals; lips both without teeth. Animal, mantle-margin with glandular tubercles, foot narrow, folded lengthwise on itself, adapted for creeping on the narrow, rounded branches of gorgoniæ and corals —on which it is supposed to feed. *C. volva*, Linn. (lxi, 18).

CRITHE, Gould. Shell ovate with produced extremities, and a delicate groove at the summit; aperture narrow, outer lip unarmed; base of the shell with about eight coarse laminæ, passing into the aperture, and having the appearance of dentations on the inner lip. *O. atomaria*, Gld. China Seas.

PEDICULARIA, Swainson.

Syn.—Thyreus, Phil.

Distr.—9 recent sp. Europe, Polynesia. 1 Miocene sp. Eur. *P. Sicula*, Swains. (lxi, 19, 20).

Shell small, limpet-like, irregular, with small, short spire, concealed with the growth, and a radiately ribbed surface when young; mouth large, lips simple, irregular. Animal with eyes sessile at the outer bases of the tentacles, mantle enclosed, not produced into a siphon in front, foot small. Operculum none.

DENTIORA, Pease. Columella plane or excavated, compressed and dentate within. *D. rubida*, Pease. Sandwich Is.

FAMILY CASSIDIDÆ.

Shell solid, subglobular or triangular; spire short, whorls sometimes varicose; aperture terminating anteriorly in a shortly recurved canal, columella callous, usually plicated, outer lip ribbed, dentate within.

Animal with large head, and eyes at the exterior base of th tentacles, proboscis cylindrical, extensible, mantle and foot larg Operculum corneous, oval or oblong.

The Cassides are active and voracious, living in sandy local ties and preying upon bivalve mollusks.

CASSIS, Lamarck.

Syn.—Cassidea, Brug. Goniogalea, Mörch. Galeodaria, Con

Distr.—37 sp Tropical; West Indies, Mediterranean, Afric China, Japan, Australia. Fossil, 36 sp. Eocene—; Chili, Franc

C. Madagascariensis, Lam. (lxii, 22)

Shell solid, thick, with the last whorl very large, varicos aperture longitudinal, narrow, outer lip with a thickened, reflecte margin, and dentate within, inner lip rugosely plicate. Ope culum oval, narrow, with median apex (lxii, 28).

These shells are well adapted for cameo-cutting, from the substance being made up of differently-colored layers, and als from a difference of hardness and texture in the various layer some approaching more nearly to the nature of nacreous than porcellanous material.

The word *cameo*, derived from the Arab word, signifying ba relief, was originally restricted to hard stones, such as ony sardonyx, etc., engraved in relief; but the name has since bee extended to gems cut on shell, lava, and other substances.

In cameos the central layer forms the body of the relief, th inner layer being the ground, and the outer the third or supe ficial color, which is sometimes used to give a varied appearan to the surface of the figure.

Shell-cameos, some years ago, were a good deal in fashio and even now a well-executed, artistic Roman shell-cameo is elegant piece of art. Genoa and Rome are the seats of the be work, although many common ones are cut in France. In Ron there are about eighty shell-cameo cutters, and in Genoa thirt some of whom also carve in coral. The art of cameo-cuttin was confined to Rome for upward of forty years, and to Ita until the last twenty-six years, at which time an Italian beg cutting cameos in Paris, and now over 3000 persons a employed in that city.

The black helmet (*Cassis Madagascariensis*), on account the advantageous contrast of colors in the layers, produc very effective cameos, the carved figure of the white upper lay being strongly relieved by the dark, almost black, ground su plied by the second layer.

The shell is first cut into pieces the size of the requir cameos, by means of diamond dust and the slitting mill, or a blade of steel fed with emery and water. It is then careful shaped into a square, oval or other form on the grindstone, a

the edge finished with oil-stone. It is next cemented to a block of wood, which serves as a handle to be grasped by the artist while tracing out with a pencil the figure to be cut on the shell. The pencil-mark is followed by a sharp point, which scratches the desired outline, and this again by delicate tools of steel wire, flattened at the end and hardened, and by files and gravers, for the removal of the superfluous portions of the white enamel. A common darning-needle, fixed in a wooden handle, forms a useful tool in this very minute and delicate species of carving. The careful manipulation necessary in this work can only be acquired by experience; the general shape must first be wrought, care being taken to leave every projection rather in excess, to be gradually reduced as the details and finish of the work are approached. To render the high parts more distinct during the process of carving they are slightly marked in black.—SIMMONDS, *Commercial Products of the Sea*, 272.

SEMICASSIS, Klein. (Cassidea, Swn.) Shell oval, with revolving ribs, spire moderate, sharp. *C. canaliculatus*, Brug. (lxii, 23).

PHALIUM, Link. (Bezoardica, Schum., 1817.) Shell varicose, angular behind, oval, with moderate spire; outer lip usually strongly dentated in front. *C. undatus*, Mart. (lxii, 24).

CASMARIA, H. and A. Adams. Shell smooth, whorls simple or subplicate, spire moderate; inner lip smooth, callous, outer lip margined, smooth or slightly crenulated on the inner edge. *C. pyrum*, Lam. (lxii, 25).

CASSIDEA, Link. (Cypræcassis, Stutchb.) Shell ovate, spire short; mouth narrow, subcanaliculate behind, columella plicate its entire length; varices none or obsolete. No operculum. The mantle-margins are reflected over the lips of the shell. *C. testiculus*, Linn. (lxii, 26).

LEVENIA, Gray. Shell oval, subcylindrical, spire short, conic; aperture narrow, contracted in the middle, columellar lip plicate throughout, outer lip without external rib, inflected and dentate. Operculum narrow. *C. coarctatus*, Gray (lxii, 27).

CASSIDARIA, Lam.

Etym.—*Cassida*, a helmet.

Syn.—Galeodea, H. and A. Adams. Morio, Montf.

Distr.—5 sp. Mediterranean. Fossil, 30 sp. Cretaceous, Eocene—; Europe, West Indies. *C. echinophora*, Linn. (lxii, 29).

Shell nodulous, ovate or oval-oblong, somewhat attenuated in front to a short, subascending canal; inner lip more or less spread over the body-whorl, tuberculated or plicate, outer lip reflected, ribbed and plicate within. Operculum corneous, ovate, summit median and marginal, outer edge sinuous.

SCONSIA, Gray. Shell oval-fusiform, with revolving striæ and a single longitudinal varix; aperture long, canal very short, and

slightly reflected; inner lip regularly plicate, the anterior cations the largest; outer lip rather thick, subreflected, pl within. Animal and operculum unknown. A single re species. *C. striata*, Lam. (lxii, 30). Also Tertiary and taceous.

ONISCIA, Sowb.

Etym.—*Oniscus*, a wood-louse.

Syn.—Morum, Bolten. Ersina, Gray. Lambidium, Link

Distr.—9 sp. West Indies, China, Galapagos. Fossil, 3 Miocene; United States, St. Domingo. *O. oniscus*, Lam. (lxii,

Shell subcylindrical, conoidal, with short spire, and c reflected at the base, surface tuberculated, mouth linear, righ reflected, thickened and plicate within, inner lip plicate.

These little shells are known by their transversely rib nodulous whorls, and prominent, recurved siphonal canal; w fresh the surface is covered with a fine velvety epidermis.

ONISCIDIA, Swains. Oval, tuberculate-cancellate, inner granulated. *O. cancellata*, Sowb. (lxii, 32).

PACHYBATRON, Gaskoin.

Distr.—3 sp. Tropical; West Indies, East Indies. *P. M ginelloideum*, Gask. (lxii, 33).

Shell small, subcylindrical, longitudinally striated; spire v short, but with sharp apex; aperture narrow, very long, inner lip spread over the body-whorl and transversely plic the outer lip thickened and denticulated within.

FAMILY DOLIIDÆ.

Shell thin, with short spire and very large body-whorl, cove with revolving ribs.

Animal very large, with a wide head bearing two elonga obtuse, distant tentacles, dilated at the base, where are situa the eyes, proboscis cylindrical, greatly developed, extens and flexible, foot oval, very large, lobed and dilated in fr with a horizontal groove. No operculum in the adult. De tion (xi, 32).

DOLIUM, Linn.

Tun-shell. *Syn.*—Perdix, Montf. Doliopsis, Conrad.

Distr.—15 sp. Mediterranean, West Indies, off Rhode Isla Ceylon, China, Philippines, Australia. Fossil, 8 sp. Cretace Tertiary; So. Europe, United States. *D. perdix*, Linn. (l 21, 34).

Shell thin, ventricose, inflated, subglobular, with revolving ri mouth very large, the outer lip crenulated, columella canal lated. The genus Macgillivraya (xx, 44, 46; lxii, 36) is foun upon the larva of Dolium; it has four tentacles, and the foo

provided with a float, like Ianthina; the larval shell has a thin, corneous operculum.

MALEA, Valenciennes.

Syn.—Cadium, H. and A. Adams.

Distr.—*M. ringens*, Swains. (lxii, 25). *M. denticulatum*, Desh. Pliocene.

Shell having the form and sculpture of Dolium, but the outer lip is thickened, somewhat reflected, and denticulated, inner lip with calloused plicate prominences.

PYRULA, Lam.

Fig-shell. *Etym.*—Diminutive of *pyrus*, a pear.

Syn.—Ficus, Rousseau. Ficula, Swainson. Otus, Risso. Sycotypus (Browne), Adams. Ficopsis, Conrad.

Distr.—8 sp. West Indies, Philippines, W. Tropical America. Fossil. Cret.; India. Cret. and Eocene; United States. *P. decussata*, Wood (lxii, 37). *P. ficus*, Linn. (lxii, 40).

Shell thin, pear-shaped, terminating anteriorly in a moderate canal; lip thin, smooth; surface cancellated or with revolving ribs.

Animal with subulate tentacles and eyes at their outer bases; mantle produced on each side, covering the shell; siphon straight, elongated; foot simple, thin, produced posteriorly. No operculum.

The Pyrulæ crawl very rapidly, bearing their light, elegantly-formed shells easily, and, with their neck stretched out, their siphon exserted, and their foot greatly expanded, present remarkable objects of contemplation to the malacozoologist. They are generally delicately flesh-tinted, with faint, marbled, crimson and pink markings; their eyes are large and black, and their long flat heads and necks usually white.

PTYCHOSYCA, Gabb. Shell shaped like Pyrula: inner lip with one anterior very oblique fold. *P. inornata*, Gabb (lxii, 39). Cretaceous; Georgia.

FICULOPSIS, Stoliczka. Pyriform, attenuated in front, inflated behind; spire very short; surface spirally and transversely striate or costulate; columella thick, angulated, plicate. *P. Pondicherriensis*, Forbes (lxii, 38). Cretaceous; So. India.

(*Macgillivrayidæ?*)

The two following genera are probably larval prosobranchiate mollusks.

ETHELLA, H. and A. Adams.

Distr.—*E. Macdonaldi*, Ad. (lxxxvii, 10, 11). Australia.

Ciliated arms six in number; creeping disk rudimentary;

operculigerous lobe long, cylindrical, bearing the operculum on its truncated extremity. Operculum claw-like, with a spiral nucleus situated near the internal or thickened border.

Shell spiral, turbinate, imperforate; spire elevated, whorls rounded; aperture oval, produced in front.

The little animal wields its clawed operculum, apparently as a weapon of defense, with great dexterity, and skips and jerks about by means of its complex foot.

GEMELLA, H. and A. Adams.

Distr.—*G. hyalina*, H. and A. Ad. (lxxxvii, 12). South Pacific.

The foot is not unlike a broad or square-toed shoe in form, receiving or bearing the remainder of the animal and the shell. The little animal creeps with great rapidity, and by hollowing the disk of its foot into a boat-form, like Limnæa, it floats upon the surface of the seas.

Operculum paucispiral, the lines of growth well-marked.

Shell subglobose, thin, pellucid, not umbilicated; spire small, compressed, whorls few, smooth; aperture large, entire.

FAMILY NATICIDÆ.

Shell globular or oval, spire usually short, aperture semilunar, without canal or anterior notch, the outer lip sharp, the columellar lip callous, more or less reflected over the umbilicus.

Animal with small tentacles, which are lanceolate, wide apart, united by a veil; eyes usually absent, or very minute and placed beneath the tentacular veil; mantle enclosed; foot much produced in front, where it is furnished with a fold which covers the head and tentacles; operculigerous lobe very ample, partially enveloping the shell. Operculum paucispiral, corneous, or with an exterior calcareous layer. Dentition, 3·1·3 (xi, 31).

The nidus of Natica (xvii, 95) is unlike that of any other mollusk in form and composition, being built up largely of the sand of the sea-bottom, formed into a partly circular form constricted into a neck above, the walls of which contain the eggs arranged in quincunx order.

NATICA, Lam.

Distr.—About 200 recent sp. World-wide, and ranging from low-water to 90 fathoms. Fossil, 500 sp. Silurian—; world-wide. *N. Alderi*, Forbes (lxiii, 41). *N. canrena*, Linn. (lxiii, 42).

Shell subglobular, spire slightly elevated, aperture half-round, a spiral columellar callus entering the umbilicus.

Animal blind, completely retractile within its shell. Operculum with an exterior calcareous layer.

The animals of Natica (typical) move quickly; they are carnivorous and very predaceous, living in sandy places, where

they hide under the surface and burrow after bivalves. Range, from low-water to 90 fathoms. The colored markings of the shells are very indestructible, being frequently preserved on fossils.

STIGMAULAX, Mörch. Whorls cancellated or sillonated; umbilicus with spiral funiculum. Operculum with calcareous outer layer. *N. cancellata*, Lam. (lxiii, 43).

LUNATIA, Gray. (Euspira, Agass., in part. Globularia, Swn.) Shell usually sombre-colored, covered with a dark, thin epidermis; not so thick as the typical group; umbilicus open, without funiculum. Operculum corneous. Inhabit usually cold or temperate rather than tropical seas. *N. heros*, Say (lxiii, 44).

NEVERITA, Risso. (Naticaria, H. and A. Adams.) Shell depressed, orbicular, spire conical or flattened; columella partly filled by a tongue-shaped callous process (funiculum) from the columella. Operculum horny. Animal capable of entire retraction within the shell. Inhabits mostly temperate seas. *N. duplicata*, Say (lxiii, 45).

ANOMPHALA, Jonas. (Cernina, Gray. Bulbus, Brown.) Globular, imperforate, the columella with heavy callous deposit. The animal is bulky, and unable to retract itself entirely into its shell. Operculum, if present, quite rudimentary. *N. fluctuata*, Sowb. (lxiii, 46).

AMPULLINA, Lam. (Globularia, H. and A. Adams. Ampullinopsis, Conr. Euspira, Agass., in part.) Umbilicus narrow (rimate), lined by a thin callus. Operculum with calcareous layer. *N. Sigaretina*, Lam. (lxiv, 66).

MAMILLA, Schum., 1817. (Ruma, H. and A. Adams. Naticaria, Swn.) Shell oval-conic, rather thin, with pointed spire; whorls fasciated; mouth oblong, inner lip narrow, reflected, usually brown or black; umbilicus not funiculated. Operculum cartilaginous, oblong, narrower than the aperture. Animal capable of retraction within its shell. *N. maura*, Lam. (lxiii, 47).

MAMMA, Klein. (Polinices, Montf. Naticella, Guild.) Shell oval or suboval, solid, smooth, spire short, sharp; aperture semicircular, inner lip oblique, callous, the callus extending into the umbilicus. Operculum corneous; animal retractile. *N. straminea*, Recluz (lxiii, 48). The shell of Mamma is usually white, sometimes colored, but not banded or spotted.

AMAURA, Möller. (Acrybia, H. and A. Adams. Ptychostoma, Laube.) Shell oval, smooth, imperforate, spire elevated, aperture oblong, columella short, simple. Operculum corneous, thin. The animal has a small, compact foot, without posterior lobe, anterior lobe profoundly sinuous, eyes at the internal base of the lobe. A boreal group, comprising a few living species. Fossil; Jurassic, Cretaceous, Tertiary. *N. candida*, Möller (lxiii, 46).

AMAUROPSIS, Mörch. Shell with canaliculated sutures. Scarcely distinct from Amaura. *N. canaliculata*, Gould (lxiii, 50).

AMAURELLA, A. Ad., 1867. Shell small, ovate, imperforate, white, shining, apex submammillary; aperture acuminately ovate; lip arcuate, simple, thick. 3 sp. Japan. *N. Japonica*, A. Ad.

LARINA, A. Adams. (Robinsonia, Nevill.) Shell thin, delicate, composed of a few rapidly increasing whorls; not umbilicated, columella simple, lip not reflexed. Epidermis olivaceous. Operculum horny, annular. Somewhat resembles Amauropsis. 6 sp. Indian Ocean, Australia. *N. Ceylonica*, Nevill (lxiii, 51). This is possibly a fresh-water shell, and perhaps belongs in Paludinidæ.

NATICOPSIS, M'Coy. (Neritomopsis, Waagen, 1880.) Shell imperforate; inner lip very thick, spreading. Operculum shelly. Carboniferous Limestone; Great Britain. *N. Phillipsii*, M'Coy (lxiv, 67).

ISONEMA, Meek. (Section of Naticopsis.) *I. humilis*, Meek (lxiv, 71). Devonian; Ohio.

TRACHYDOMIA, Meek and Worthen, 1866. (Section of Naticopsis.) Surface covered by small regularly disposed tubercles. *N. nodosa*, M. and W. Carboniferous; Illinois.

EUSPIRA (Agassiz), Morris and Lycett. (Holopea, Hall, in part.) Spire more or less elevated; whorls few, distinct, angulated or carinated. Inferior Oolite; England. "Euspira presents considerable affinities to the Palæozoic genus Scalites, Hall, in the lines of growth having the appearance of a slight fissure, where the angle occurs in the volution."—MORR. and LYC. *N. canaliculata*, Morr. and Lyc. (lxiv, 84).

GYRODES, Conrad, 1860.

Distr.—Cretaceous; U. S., Europe, India. *G. alveata*, Conr. (lxiv, 70).

Shell depressed-globose; aperture generally angular or narrowly rounded below; inner lip thin; umbilicus wide, deep, without callosity, bounded by a revolving carina which is sometimes crenate, with occasionally a second small revolving ridge within; whorls shouldered above, the angle generally wrinkled or crenate.

CLOUGHTONIA, Hudleston.

Distr.—*C. (Phasianella) cincta*, Phillips. Oolite; England.

Shell short, conical and solid, with a widish base; whorls about five, flat and angular; body-whorl more or less bicarinated with slight depression of the intervening space; aperture ovate to ovate-oblong, rounded anteriorly; pillar nearly straight, with little or no callus.

This group seems to occupy an intermediate position between Natica and Chemnitzia.

TYCHONIA, de Koninck, 1881.

Distr.—*T. Omaliana*, de Kon. Carboniferous; Belgium.

Shell somewhat depressed, globular, smooth; spire short, obtuse, sutures shallow; last whorl very large; mouth semicircular, outer lip sharp, inner lip somewhat callous; an umbilical fissure.

SIGARETUS, Lam.

Syn.—Catinus (Klein), H. and A. Adams. Lupia, Conr. Stomatia, Hill. Raynevallia, Ponzi.

Distr.—90 recent sp. United States, West Indies, China, Peru. Fossil, 10 sp. Eocene—. *S. neritoideus*, Linn. (lxiii, 52).

Shell ear-shaped, with minute spire and very large aperture, externally with revolving striæ, color usually white, with sometimes a thin corneous epidermis. Operculum minute, horny, subspiral. Animal with large mantle partly or entirely covering the shell, anterior foot-lobe enormously developed.

They live on muddy sand-flats; in their habits they are sluggish and slow-moving, and very timid; when crawling they constantly explore the surrounding surface with the produced fore-lobe of the foot, which is also used in burrowing.

SIGARETUS, Lam. (typical). Shell orbicular, conoidal or convex; mouth rounded; umbilicus open or covered by a reflection of the inner lip; spire short, oblique.

NATICINA, Gray. (Lacunaria, Conr.) Shell oval-oblong, thin, ventricose; spire sharp; inner lip straight, thin anteriorly, with a median callus; umbilicus open or partly covered. *S. papilla*, Gmel. (lxiii, 53).

CRYPTOSTOMA, Blainv. Shell ear-shaped, flattened; spire short, depressed; mouth very large, oblique; no umbilicus. *S. haliotoides*, Linn. (lxiii, 54).

VELUTINA, Fleming.

Etym.—*Velutinus*, velvety (from *vellus*, a fleece).

Syn.—(?) Catinella, Stache.

Distr.—4 sp. Boreal Seas, Europe and America. Fossil. Triassic, Cretaceous, Pliocene—. *V. capuloidea*, Blainv. (lxiii, 55). *V. lævigata*, Linn. (lxiii, 56).

Shell thin, with a velvety epidermis; spire small, sutures well-impressed; aperture very large, rounded; peristome continuous, thin. No operculum.

Animal with a large oblong foot; margin of the mantle developed all around, and more or less reflected over the shell; head broad; tentacles subulate, blunt, far apart, with eyes on prominences at their outer bases.

The Velutinas, although resembling the pulmoniferous genus Otina, are strictly marine, being met with sometimes far out at

sea: usually, however, they are found living on stones nea[illegible] water.

VELUTELLA. Gray. Shell thin, flexible, pellucid, smooth, [illegible]branaceous: spire somewhat elevated: mouth oblong, col[illegible] flexuous. *V. flexilis*, Mont. (lxiv. 86).

[LIMNERIA. H. and A. Adams. (Morvillia, Gray.) Shell globose, with wide expanded aperture, sometimes extendin[illegible] teriorly beyond the apex: inner lip oblique, reflexed poste[illegible] straight and acute anteriorly. *V. zonata*, Gould (lxiii, 6[illegible] which has been referred to the pulmoniferous genus Otin[illegible] typical species.]

LEPTONOTIS, Conrad. Differs from Velutina in the rema[illegible] expansion of the outer lip, and the distance of the apex [illegible] the margin. *V. expansa*, Whitfield (lxiv. 68, 69). E[illegible] Alabama.

AMPLOSTOMA, Stoliczka. Subovate, thin, spire short; [illegible] few, the last large, ventricose, produced in front, widely [illegible]vated at base; aperture elongately ovate, subangulated. [illegible] lip smooth, outer lip dilated and expanded at the m[illegible] surface nearly smooth. Cretaceous: So. India, Europ[illegible] *auriforme*, Stoliczka (lxiv. 85).

PLATYOSTOMA, Conrad.

Etym.—*P. Niagarensis*, Hall (lxiv. 74). Niagara group [illegible] York.

Shell subglobose: spire short: aperture very large, sub[illegible]ular, dilated; labrum joining the body-whorl at right-ang[illegible] the axis of the shell.

STROPHOSTYLUS, Hall. Shell subglobose or ovate-globose; [illegible] small, with a large, ventricose body-whorl; outer lip thi[illegible] reflected, sometimes slightly expanded; columella twis[illegible] spirally grooved within, not reflected; umbilicus none; ap[illegible] somewhat round-ovate or transversely [illegible]. Fossil [illegible] Helderberg. *S. [illegible]*, Hall (lxiv. 75). In this the col[illegible] is said to be twisted [illegible] spirally grooved within, whilst in [illegible] the columellar lip is simply thickened.

[illegible]. Meek-Chal. 1874. Umbilicus moderate, c[illegible] [illegible] by a [illegible]; which is sometimes partially free. [illegible] [illegible]. Meek-Chal. Devonian.

[illegible], Gabb (p. [illegible]), may perhaps be united to Veluti[illegible]

LAMELLARIA, Montagu.

Etym.—*Lamella*, a thin plate.

Syn. Lamell[illegible] [illegible].—[illegible] ([illegible]. 3. [illegible] [illegible] [illegible]xxxvi. 8. [illegible]. Chelyonotus. [illegible] [illegible] [illegible] Swa[illegible] [illegible] Jason[illegible] Macdonald. Echinospira. Krohn. E[illegible] [illegible] xx. 49. 54).

Distr.—10 sp. Norway, Great Britain, Mediterranean, New Zealand, Philippines. Fossil, 2 sp. Pliocene.

Shell ear-shaped; thin, pellucid, fragile; spire very small; aperture large, patulous; inner lip receding. No operculum.

Animal much larger than the shell, which is entirely concealed by the reflected margins of the mantle; mantle non-retractile, notched in front; eyes at the outer bases of the tentacles. Lingual uncini 3, similar; or one very large.

Lamellaria perspicua (lxiii, 57, 58) lays its eggs in February and March; it hollows out a nest in the colonies of the compound Ascidians, from which it derives its nourishment. The nest is closed by a transparent operculum, presenting circular and concentric striæ, showing that the animal turns round during oviposition. Each capsule contains besides the normal eggs a certain number of rudimentary ones, which later serve for the nourishment of the embryos. The first shell formed is nautiloid, presenting two dorsal and two lateral keels (xx, 49, 50); the second shell, formed within the first, is more simple, like a Carinaria: the two are united at their apertures by a thin membrane. —Giard, *Comptes Rendus*, 736, 1875.

Dr. J. Gwyn Jeffreys remarks of the same species:—

The mantle, tentacles and foot assume different positions when the animal is quiescent and in active motion. It swims or floats with apparent ease. The gill-plume (whether single or double I could not make out) is of a yellowish brown color. Mr. Daniel found constantly in the stomach portions of branched corallines, probably indicating that the Lamellaria feeds on Polyzoa. According to Mr. Peach the female eats a round hole in a jelly-like compound Ascidian (*Leptoclinum punctatum*) for the purpose of making her nest and depositing in it her eggs. This nest is pot-shaped, and covered by a circular lid; it is at first bright yellow, which afterwards sometimes fades and changes, becoming at last dirty white. As the embryo increases in size the nest rises up beyond the surface of the Ascidian, having been previously covered on all sides. The spawn is deposited from February to May; it arrives at maturity in four or five weeks. The embryo, when enclosed and swimming in the glairy matrix, is of a somewhat triangular shape; the front portion is trilobed, each lobe being furnished with delicate vibratile cilia which are in constant motion; the central portion is granular, and the hinder bluntly pointed. On the pot-lid bursting open and the fry emerging, the latter is found to have a pellucid nautiliform shell, retaining in other respects the appearance of its fœtal state, and destitute of tentacles, eyes or foot. Mr. Peach's excellent observations were continued regularly for ten years. Every season the Lamellaria, as if impelled by the same instinct

which takes the salmon to the river, and the herring to shallow water, migrated inshore and sought its proper spawning grou

MARSENINA, Gray. (? Colobocephalus, M. Sars.) Shell opaq with short spire; animal with mantle fissured down the ba *L. depressa*, Sutton (lxiii, 59).

ONCHIDIOPSIS, Bergh. Shell entirely enclosed by the anim thin, slipper-like, without spire, margin entire. Animal ver cose, with a lanceolate foot. *O. glacialis*, M. Sars (lxiv, 72, 7 Norway.

CRYPTOCELLA, H. and A. Adams. Shell thin, pellucid, cal reous; spire small, mouth very large; animal with depress subverrucose or smooth mantle. *L. tentaculata*, Mont. (lxiii, 6 *L. latens*, Müll. (lxiii, 61).

CORIOCELLA, Blainv. Shell spiral, calcareous, thin, subopaq spire short, whorls rounded, the last large, aperture very lar Mantle of animal deeply fissured and bilobed in front, the surf depressed and covered with numerous hexagonal tubercl This group was founded by Blainville upon an animal accidenta deprived of its shell. *L. nigra*, Blainv. (lxiii, 62, 63).

VANIKORO, Quoy and Gaimard.

Syn.—Narica, Recluz. Merrya, Gray. Leucotis, Sowb.

Distr.—25 sp. West Indies, Nicobar, Philippines, Polynes Fossil. Gault —; Europe, U. S. *V. cancellata*, Chen (lxv, 90).

Shell subglobose, external, white, with sometimes a velv epidermis, striated, costate or decussated, umbilicated, umbilic without a trace of callus. Operculum very thin, corneous, spiral.

Probably most of the jurassic and triassic species of Neritop belong to Vanikoro, as certainly do nearly all the spec described by Münster and Klipstein from St. Cassian under t name of Naticella. There are numerous cretaceous species fr the old world.

VANIKOROPSIS, Meek. Shell subglobose, thick and solid; bo volution large; spire depressed; aperture ovate; axis imp forate; outer lip simple, beveled; inner lip closely folded up and adhering to, the columella and the body-volution, very lit thickened and not flattened, toothed, notched, or serrated; surf with distinct revolving lines and furrows, and on the bo volution developing strong oblique folds or plications a furrows, parallel to the lines of growth. *N. Tuomeyana*, M. a H. (lxiv, 87). Cretaceous; Upper Missouri River.

NATICODON, Ryckholt. Shell globose like Vanikoro, but t inner lip usually thickened and always provided with some ki of a tooth; the columella is either slightly hollowed out or soli the surface smooth or ornamented with various spiral or tra

verse striæ. Palæozoic. A connecting link between Vanikoro and Neritopsis; the former having the columellar lip smooth, the latter insinuated in the middle, or provided with two strong teeth, while Naticodon has only one tooth; as regards the thickness of the shell this transition seems equally to hold good. *N. spiratum*, Sowb. (lxiv, 76). Carboniferous; Europe.

FAMILY CALYPTRÆIDÆ.

Shell limpet-like, with the apex more or less spiral; interior simple, or divided by a shelly process, variously shaped, to which the adductor muscles are attached.

Animal with a distinct head; muzzle lengthened; eyes on the external bases of the tentacles; branchial plume single. The rostrum is prominent and split, but non-retractile.

The bonnet-limpets are found adhering to stones and shells; most of them appear never to quit the spot on which they first settle, as the margins of their shells become adapted to the surface beneath, whilst some wear away the space beneath their foot, and others secrete a shelly base. Both their form and color depend on the situation in which they grow; those found in the cavities of dead shells are nearly flat, or even concave above, and colorless. They are presumed to feed on the sea-weed growing round them, or on animalcules; a Calyptræa, which Professor Forbes kept in a glass, ate a small sea-slug (Goniodoris) which was confined with it. Both Calyptræa and Pileopsis sometimes cover and hatch their spawn in front of their foot.

The use of the calcareous lamina, which is the first stage in the formation of a columella, is to support the viscera and separate them from the foot or locomotive organ.

GALERUS, Humphrey.

Syn.—Sigapatella, Siphopatella, Lesson. Mitella, Leach.

Distr.—Tropical and subtropical. *G. Chinensis*, Linn. (lxvi, 22, 23). Fossil. L. Cretaceous—.

Shell depressed subconical, spiral, summit subcentral, aperture very large, basal, with a subspiral broad lamina adhering to the left margin. Animal with bilabiate muzzle, buccal appendages short, rounded; a slightly developed, plain-edged neck-lobe; foot auriculate in front.

GALEROPSIS, Conrad. Spire more elevated. *G. excentricus*, Gabb. Eocene.

INFUNDIBULUM, Montfort.

Syn.—Trochita, Schum., 1817. Clypeola, Gray. Trochella, Gray.

Distr.—Mostly tropical and subtropical. *I. spirata*, Forbes (lxvi, 24, 25). Fossil. Tertiary; U. S., West Indies.

Shell conic, trochiform, spiral; summit central; whorls convex, plicate, not umbilicated; aperture large, containing a spiral transverse lamina, extending obliquely from the centre to the outer margin of the shell. The animal has an oblong foot, bilobed anteriorly.

HALIOTIDEA, Swainson. Shell conic, spiral, the spire excentric, whorls convex, smooth, umbilicated. *I. dilatata*, Sowb. (lxvi, 26).

CALYPTRÆA, Lam.

Cup and saucer limpet.

Syn.—Cemoria, Risso. Mitrella, Trochilina, Trelania, Poculina, Gray. Mitrularia, Schum. Lithedaphus, Owen.

Distr.—Temperate and tropical; world-wide. *C. Martiniana*, Reeve (lxvi, 27).

Shell conical, more or less regular, with subcentral, subposterior sharp apex; aperture basal, with a central lamina, half cup-shaped, attached to the apex and open in front.

Animal with broad muzzle; tentacles rather short, lanceolate; eyes on bulgings at the outer bases of the tentacles; mantle-margin simple, sides plain.

CRUCIBULUM, Schum., 1817.

Syn.—Bicatillus, Biconia, Swains. Siphopatella, Lesson. Trelania, Neleta, Gray.

Distr.—Temperate and tropical; world-wide. *C. rudis*, Brod. (lxvi, 28).

Differs from Calyptræa in the internal cup-shaped lamina, which is entire and attached along a line on one side to the inner wall of the shell.

DISPOTÆA, Say. (Calypeopsis, Lesson.) Cup-shaped lamina adhering to the whole of one side. *C. striata*, Say (lxvi, 29).

CATILLINA, Gray. Oblong, conical, radiately ribbed; the apex acute, subcentral, recurved; nucleus regular, spiral; cavity conical, with a broad trigonal cup on the left side under, but not extending to the apex of the cavity, filled with a callous deposit at the tip; the part of the cup next to the inner surface of the shell scarcely thickened and not raised up. *Crucibulum concamerata*, Rve. (lxiv, 77).

CREPIDULA, Lam.

Etym.—*Crepidula*, a small sandal.

Syn—Crypta, Humph. Sandalium, Schum. Crepipatella, Lesson (?). Tylacus, Lyroscapha, Conrad.

Distr.—50 sp. West Indies, Atlantic and Pacific Coasts of N. America, Mediterranean, W. Africa, India, Australia. *C. Peruviana*, Lam. (lxv, 91). Fossil. Cretaceous—.

Shell oval, limpet-like, with a posterior, generally lateral spiral apex; interior with a shelly lamina covering its posterior half.

Animal. Head large, transverse, depressed; foot rounded, slightly truncate in front.

Adhering to shells or stones, and modifying their form in accordance with their dwelling-place, those species living within the aperture of empty spiral shells are generally flat and uncolored; others reproduce the ribs of Pecten; others again attach in groups upon the outside of each other's shells.

GARNOTIA, Gray. Oval, convex, covered by a smooth epidermis; apex dorsal, median, posterior; lamina inclined.

IANACUS, Mörch. Shell depressed, apex posterior, but slightly lateral; lamina mostly concave in front. *C. unguiformis*, Lam. (lxv, 92).

ERGÆA, H. and A. Adams. Shell depressed, summit lateral; lamina produced in front, its columellar margin subtubular. *C. plana*, Ads. and Rve. (lxv, 93).

NOICIA, Gray. Shell subcircular or oblong, convex, spiral; whorls one and a half or two; the apex subcentral, subposterior; nucleus spiral; cavity concave, deeper under the apex; internal plate concave, thin, with the fold forming a narrow linear cavity open to the apex of the shell. *N. Chinensis*, Gray. China.

SPIROCRYPTA, Gabb. Summit of shell posterior, lateral and submarginal, spiral. Internal plate attached to the margin on the lower or outer side, curving upwards and inwards and uniting with the opposite side at a considerable distance. The plate is subspiral, thus approaching Trochita and Galerus. *C. pileum*, Gabb (lxiv, 78). Cretaceous; Cal.

GALERICULUS, Seeley.

Distr.—*G. altus*, Seeley (lxiv, 79).

This genus has two separate septa, the larger one originating below the incurved apex, and the smaller one at the base. Only the cast is as yet known; the upper surface of the shell, which has the form of a Helcion, not having been observed.

CAPULUS, Montf.

Bonnet-limpet.

Syn.—Pileopsis, Lam. Actita, Fischer de Wald.

Distr.—8 sp. W. Indies, Europe, India, Australia, W. America. Fossil, 20 sp. Silurian—. *C. Ungaricus*, Linn. (lxvi, 30).

Shell conical, apex posterior, spirally recurved; aperture rounded; muscular impression horseshoe-shaped.

Tongue-membrane winged on each side in front, teeth arranged in seven series (3·1·3), central teeth small and broad with the apex hooked, the lateral teeth long and hamate. Rostrum lengthened; tentacles subulate, with the eyes on bulgings at their outer bases. Mantle simple in front; gill forming a single plume placed obliquely across the mantle-cavity, laminæ elongate, linear, partly exposed. Foot folded on itself, the sides simple,

anteriorly thin and strap-shaped, posteriorly thick, orbicular and concave.

These animals are said to feed on the sea-weed that grows around them, and on small marine organisms. They appear to have but limited locomotion, being usually adherent and modifying the margin of the aperture of the shell according to the surface on which they live. Sometimes they wear away the surface beneath their foot, forming shallow excavations, or they secrete an imperfect shelly base by means of the same organ. The egg-cases are membranous and are attached in a tuft at the front of the foot under the neck.

THYCA, H. and A. Adams, 1854. Shell conical, transparent, slightly curved, with longitudinal grooves. Occurs on Asteria. *C. astericola*, Ad. and Reeve.

BROCCHIA, Bronn. Irregularly conical, apex slightly spiral; left margin with a profound sinus; posterior half of the margin folded. 2 sp. Tertiary. A doubtful group. *C. sinuosa*, Bronn (lxiv, 80).

PLATYCERAS, Conrad.

Syn.—Acroculia, Phillips.

Distr.—Fossil, 50 sp. Silurian to Carboniferous; United States, Europe. *P. ventricosum*, Conr. (lxiv, 81, 82).

Shell depressed subglobose, subovoid or obliquely subconical; spire small; volutions few, sometimes free and sometimes contiguous, without columella; aperture more or less expanded, often campanulate, and sometimes with the lip reflexed; peristome entire or sinuous. Surface striated or cancellated, often spirally ridged or plicate, and sometimes strongly lamellose transversely, nodose or spiniferous.

The subglobose species resemble the Velutinæ, but there is every degree of variation in form between these and non-spiral shells. From among these, two subgeneric groups have been rather arbitrarily separated.

ORTHONYCHIA, Hall. Body of the shell straight or curving, gradually diminishing above, arched or in some degree spiral at the apex, with the last volution or more quite free. Sil. to Carb. *P. spirale*, Hall (lxiv, 83).

IGOCERAS, Hall. Shell straight, with cancellated surface and often with the addition of longitudinal plications. Silurian. *P. pileatum*, Conrad.

BERTHELINIA, Crosse.

Distr.—*B. elegans*, Crosse (lxv, 94, 95). Fossil. Paris basin.

Capuliform, very small, microscopic, thin, rather smooth, few-whorled, the spire very small and lateral, the last whorl greatly dilated with a large aperture.

SPIRICELLA, Rang.

Distr.—*S. unguiculus*, Rang (lxv, 96, 97). Miocene; France.

Shell flattened, elongated, with a small sinistrally spiral apex. Perhaps as nearly related to Umbrella.

AMATHINA, Gray.

Distr.—*A. tricarinata* (lxv, 98, 99). India.

Shell depressed, oblong; apex posterior, not spiral, with three strong ribs radiating from it to the anterior margin, which is produced into three points.

Head elongated; eyes sessile on the posterior lateral margins behind the tentacles; tentacles short, obtuse; mantle-margin entire, a tentacular median filament at the hind-part.

HIPPONYX, Defrance.

Etym.—*Hippos*, a horse, and *onyx*, a hoof.

Syn.—Cochlolepas, Klein. Krebsia, Mörch.

Distr.—10 sp. W. Indies, W. America, Indian Ocean, Philippines, Australia. Fossil, 10 sp. Cretaceous; United States, Europe. *H. cornucopiæ*, Lam. (lxv, 100, 1, 2).

Shell thick, obliquely conical, non-spiral, apex somewhat posterior and curved backwards; muscular impression horseshoe-shaped; base of attachment shelly, secreted by the foot of the animal.

Animal oval or suborbicular, conical or depressed; foot very thin, a little thickened towards the margins; head globose, separated from the body by a neck-like constriction; eyes upon swellings of the tentacles.

AMALTHEA, Schum., 1817. (Sabia, Gray.) Like Hipponyx, but forming no shelly base; surface of attachment worn and marked with a crescent-shaped impression. Often occurs on living shells, such as the large Turbos and Turbinellæ of the Eastern seas. *H. conica*, Schum. (lxv, 3, 4).

FAMILY ONUSTIDÆ.

Shell conical, spiral, depressed, umbilicated, soldering shells and stones to its exterior surface.

Animal. Foot small, cylindrical, used for jumping, not walking, having an expanded front, and a tapering hind-portion. Operculum large, horny, subannular, right half free, nucleus lateral, dextral; muscular impression sinistral, semilunar, extending the whole length.

These animals scramble along like the Strombs; they extend and fix the front, dilated part of the foot and draw the hind-lobe up to it, throwing forwards the shell at every movement. They cannot glide like other mollusks, but the form of the foot is

admirably adapted to to the nature of the floor on which they live, which is usually composed of the debris of dead shells.

ONUSTUS, H. and A. Adams.

Syn.—Haliphœbus and Tugurium, Fischer.

Distr.—Several sp. Tropical: East and West Indies. *O. solaris*, Linn. (lxvi, 31, 32). Fossil. Devonian—.

Shell conical, trochiform, depressed, widely and profoundly umbilicated; periphery of the whorls fringed with regularly disposed tubular spines or slight projections; pieces of small shells agglutinated upon the whorls at the sutures, where they are attached as growth continues.

EUTROCHUS, Whitfield, 1882.

Distr.—*E. concava*, Hall. Carb.; Ind., Ills.

Shell conical above, flat or concave beneath, and broadly and deeply umbilicated; aperture very oblique, and the outer angle of volutions strongly carinated or expanded; surface ornamen— tation unlike on the upper and lower surfaces.

Differs from the umbilicated forms of Trochidæ in not forming a columella; the lower or basal surface sloping gradually and smoothly into, and forming the sides of, the umbilicus, giving an obliquely elliptical section to the volution.

XENOPHORA, Fischer de Wald.

Syn.—Phorus, Montf. Pseudophorus, Meek.

Distr.—Several sp. Tropical. *X. conchyliophora*, Born (lxvi, 33). Fossil. Devonian—.

Shell conical, trochiform, whorls flattened, carrying shells, madrepores and stones, miscellaneously arranged and attached anywhere upon the exterior surface, so as to completely disguise the dorsal aspect of the shell; lower surface free of extraneous agglutinations; umbilicus narrow, sometimes covered by the inner lip.

The "carriers" inhabit deep water, and are most numerous in the Java and China Seas. Each species appears to have its own peculiar method of collecting the fragments of shells and stones which cover the ground where it lives, and each cements to the outside of the shell its particular kind of materials. The adventitious pieces of shell are so disposed as not to curve downwards beyond the edge of the shell, so as to impede the progress of the animal, but are usually placed with their concave sides uppermost, and the purpose of this structure is evidently concealment of the true nature of the animal, either for attack or defense, or perhaps for both occasions; as when tricked out with shells and stones it may well be mistaken for a refuse-heap.

ENDOPTYGMA, Gabb, 1877. Differs from Xenophora in having

a strong revolving plate inside, nearly midway between the umbilical and outer margin on the base. Cretaceous; Miss. and Alabama; described from a cast. *X. umbilicata*, Tuomey.

FAMILY SOLARIIDÆ.

Shell orbicular, depressed or trochiform; aperture generally angular; umbilicus usually wide and deep. Operculum corneous, spiral.

The animal has folded tentacles, with the suture below; eyes sessile on the upper surface of their bases; gill-cavity divided by a longitudinal fold; proboscis retractile.

The shells are not pearly like Trochus—which many of them resemble. They are numerously represented in fossil deposits, commencing in the Trias, and reaching their maximum in the Tertiary. There are not many living species. Dentition (xii, 39, 40).

SOLARIUM, Lam.

Etym.—*Solarium*, a dial.

Syn.—Architectonica, Bolten. Solariorbis, Conrad.

Distr.—25 sp. Tropical; world-wide. Fossil, more numerous. Commencing with the Eocene. *S. perspectivum*, Linn. (lxvi, 34).

Shell depressed conic, angular at the periphery; aperture subquadrangular, lip simple; umbilicus wide, spiral, its margins crenulated. Operculum horny, subspiral.

TORINIA, Gray. (Heliacus, d'Orb.) Shell orbicular, elevated, granulated, last whorl rounded; moderately but profoundly umbilicated. Operculum conically elevated, of numerous volutions, which are margined by projecting edges cork-screw fashion. *S. variegatum*, Lam. (lxvi, 35).

Distinguished from Solarium by its spirally elevated operculum, and by the rounded periphery of the last whorl. They affect deep water, and are very shy and sensitive when under observation.

PHILIPPIA, Gray. (Disculus, Desh.) Shell smooth, subconic; umbilicus with crenulated margins. Operculum flattened, whorls numerous. *S. luteum*, Lam. (lxvi, 36).

GYRISCUS, Tiberi. Shell turbinated, conic-turriculated, umbilicated, rather obtuse, the summit enveloped. Whorls rounded, transversely sculptured. Aperture subcircular, the simple margins united by a callous deposit; columellar lip reflected. Operculum corneous, multispiral externally, furnished internally with a central styliform projection. *S. Jeffreysianum*, Tiberi (lxv, 5, 6). Mediterranean.

FLUXINA, Dall. Shell porcellanous, depressed conical, umbilicate, strongly carinate, with a stout umbilical rib, above which the pillar is thin and emarginate; from the umbilical rib to the

carina the basal margin of the aperture is deeply flexuously emarginate; above the carina it is again, but less deeply, emarginate, then sweeps forward roundly, and then slightly recedes before joining the preceding whorl. This curious form belongs in all probability to the Solariidæ, representing among them Basilissa among the Trochidæ, and recalling Platyschisma, but with a different aperture. When perfect, the margin at the carina must project forward like a claw or nail, as in Schizostoma. When adult, the nuclear whorls are filled up with a solid deposit of shelly matter, and it is probable that there is a slight notch at the end of the umbilical rib. *S. brunnea*, Dall. West Indies.

PLATYSCHISMA, M'Coy.

Distr. — Silurian—; U. S., Europe. *P. Uchtensis*, Keys (lxv, 7).

Shell depressed trochiform, whorls somewhat rounded, ornamented with small transverse ribs; spire short, whorls few; aperture oblique; umbilicus small, rounded.

ARCHITEA, Costa.

Syn.—Trachysma, Jeffreys.

Distr.—*A. delicatum*, Phil. (lxv. 8).

Shell turbinate, but little elevated, thin, widely and deeply umbilicated below; aperture rounded, peristome continuous, simple. Operculum corneous, pellucid, spiral, flattened and smooth on the outer side, the spire slightly prominent in the centre of the inner side.

STRAPAROLLUS, Montfort, 1810.

Syn.—Euomphalus, Sowb. Helicotoma, Salter. Pleuronotus, Hall. Helicites, Schloth. Centrifugus and Inachus, His. Cirrus, Sowb. Phanerotinus, Sowb. (partim). Omphalocirrus, Planicirrus, Echinocirrus and Trochocirrus, Ryckholt. Omphalotrochus, Meek. Phymatifer, Kon. Straparollina, Billings.

Distr.—60 sp. Lower Silurian to Trias; United States, Europe, Australia. *S. Gualteriatus*, Vern. (lxv, 9). *S. calcar*, d'Orb. (lxv, 21).

Shells depressed, whorls angular or carinated, aperture subquadrangular, umbilicus wide, conical. Operculum shelly, multispiral.

It has been proposed by several conchologists to unite the genera Straparollus (= Euomphalus) and Solarium in one. When, however, we compare the large number of species of both these genera, it appears that the smooth or at least less ornamented surface of the shell, the constant want of a distinctly crenulated margin round the umbilicus, combined with the roundish form of the whorls of Straparollus, make its separation

from Solarium very desirable. Of many of the palæozoic Straparolli the opercula are known, and they very much resemble those of Torinia, being thick and composed of numerous lamellar volutions.

[MACLUREA, Emmons. Shell discoidal, sinistral, flattened above, rounded below; surface smooth or transversely striated. Probably more nearly related to Bellerophontidæ and Haliotidæ, in the vicinity of which it will be more fully described. *S. magna*, Lesueur (lxv, 10).]

SCHIZOSTOMA, Bronn. Shell dextral or sinistral, planorbiform, the whorls flattened or convex; aperture triangular or transverse, the margins sinuous above and below, uniting in a produced point at the periphery. *S. Puzosii*, Vern. (lxv, 11).

CŒLOCENTRUS, Zittel. Shell low conical, widely umbilicated, with rounded or angular whorls, having one or two series of tubercles or hollow spines; aperture round, with entire lip. Devonian to Trias. *S. Goldfussi*, d'Arch.

EUOMPHALOPTERIS, Roemer. Shell low conical, widely and deeply umbilicated; periphery seamed, with fine radial channels. Operculum shelly, concentrically striated and swollen externally, showing spiral whorls internally. *S. alatus*, His. U. Silurian.

[RAPHISTOMA, Hall. (Helicotoma, Salter.) Shell lenticular or orbicular, whorls flattened with a carination above; umbilicus moderate; outer lip with slight sinus at the keel. *S. striatus*, Hall. See p. 223.]

HELICOCRYPTUS, d'Orb.

Distr.—*H. pusillus*, d'Orb. (lxv, 12). Corallien.

Shell depressed orbicular, volutions on the same plane; the outer one nearly embracing the others, so that it shows a small depressed spire above, and a narrow umbilicus below.

Stoliczka places this genus near Rotella; it is perhaps as nearly related to that genus as to the Solariidæ.

ADEORBIS, S. Wood.

Distr.—10 sp. West Indies, China. Low-water to 60 fms. Fossil, 5 sp. Eur. *A. subcarinatus*, Mont. (lxv, 13).

Shell depressed orbicular, widely umbilicated; whorls not numerous, smooth or striate, the last sometimes angular; aperture rounded, the outer lip arcuated, simple, sharp. Operculum shelly, subspiral.

OMALAXIS, Desh.

Distr.—*O. supranitida*, Wood (lxv, 14).

Shell subdiscoidal, whorls distinctly carinate, peristome not continuous. Operculum elevated, multispiral.

HOMALOGYRA, Jeffreys.

Syn.—Omalogyra, Jeffreys. Ammonicerina, Costa.

Distr.—2 sp. Europe, Greenland. *H. atomus*, Phil. (lxv, 15, 16).

Shell planorbiform, with involute spire; whorls more or less angulated; mouth clasping both sides of the periphery. Operculum few-whorled, nucleus central.

Body flattened, tentacles wanting, eyes sessile behind the head.

CYRCULUS, Jeffreys.

Distr.—*C. striatus*, Phil. (lxvi, 37). Mediterranean.

Shell minute, discoidal; umbilicus large, profound. Operculum multispiral, corneous.

DISCOHELIX, Dunker.

Syn.—Orbis, Lea (not Blainv. or Lacep.). Bifrontia, Desh. Ilaira, H. and A. Adams. Platystoma, Hörnes.

Distr.—*D. zanclea*, Phil. (lxv, 17, 18). Fossil. Silurian, Liassic, Cretaceous, etc.

The genus was proposed for a liassic, discoidal shell, composed of quadrangular whorls, carinated and more or less crenulated on the upper and lower edges of the back, on which the striæ of growth are insinuated backwards.

OPHILETA, Vanuxem.

Syn.—Cyclogyra, Wood. Planaria, Brown. Discohelix, Adams and Chemn.

Shell planorbiform, discoidal, whorls numerous, slender, in contact.

Proposed for a palæozoic fossil of New York (*O. levata*, Hall, lxv, 19); to which may be added the recent *Discohelix foliacea*, Phil. (lxiv, 88, 89).

ECCYLIOMPHALUS, Portlock, 1843.

Syn.—Serpularia, Roemer. Phanerotinus (partim), Sowb., 1842.

Distr.—Fossil. Palæozoic, a few species. *E. serpula*, Kon. (lxv, 20).

Shell discoidal, whorls few, in the same plane, widely dissolute; flattened above, rounded beneath.

FAMILY SCALARIDÆ.

Characters those of the only genus. These mollusks are closely related to the Ianthinæ, of which they may be regarded as creeping representatives, on the one side, and to Turritella as well, by the form of their shell. Dentition (xi, 36–38).

SCALARIA, Lam.

Etym.—*Scalaris*, like a ladder. Wentle-trap.

Syn.—Sthenorytis, Compsopleura and Scalarina, Conr.

str.—150 sp. Mostly tropical; Greenland, Norway, Britain, terranean, West Indies, China, Australia, Pacific, West rica. Fossil, nearly 200 sp. Trias—; Britain, North rica, Chili, India. *S. pretiosa*, Linn. (lxvi, 42).

ell mostly pure white and lustrous; turreted; many-whorled; ls round, sometimes separate, ornamented with numerous verse ribs; aperture round; peristome continuous. Oper- a horny, few-whorled.

imal with a retractile proboscis-like mouth; tentacles close her, long and pointed, with the eyes near their outer bases; le-margin simple, with a rudimentary siphonal fold; foot ely triangular, with a fold (mentum) in front. Sexes dis- ; predaceous. Dr. Gould fed them on raw beef, which they oraciously; tongue armed with numerous simple uncini. e from low-water to 80 fathoms. The animal exudes a e fluid when molested.

THRUS, Oken. Shell moderately thick, whorls united, tudinal ribs numerous, aperture suboval, umbilicus covered e left lip. *S. communis*, Lam. (lxvi, 38).

LIA, H. and A. Adams. (Psychrosoma, Tapparone-Canefri. sopleura, Conr.) Shell turriculated, imperforate, whorls d, the last with a spiral rib at the base. *S. coronata*, Lam. 39).

EA, H. and A. Adams. Shell turriculated, thin, whorls d, cancellated, with some thin irregular varices; aperture unar, interior lip gibbous in the middle, exterior lip thin, e. *S. magnifica*, Sowb. (lxvii, 45).

SOTREMA, Mörch. Shell turriculated, solid, whorls cancel- , with a few irregular thick varices; mouth circular, outer in of aperture thickened with an externally crenulated lip. *ricosa*, Lam. (lxvi, 40).

RSA, Mörch. Shell turreted, thin, whorls united, varices ete, outer lip thin, simple. *S. Eschrichtii*, Holb. (lxvi, 43).

IS, Seeley, 1861. Shell turreted, thin; whorls ornamented transverse laminar ribbings and usually also with spiral so as to produce a cancellated surface; aperture ovate, thin margins, anteriorly subeffuse. *S. elongata*, Seeley , 46). Fossil. Cambridge Greensand; England. Inter- ite between Scalaria and Turritella.

SSEA, A. Ad. Shell turbinate, umbilicated, white; whorls x, cancellated, simple or with varices; aperture roundish, orly angular, somewhat produced and canaliculated; umbil- urrounded and narrowed by a callus. 2 sp. Japan. *S. ida*, A. Ad. (lxvii, 47).

ILLA, A. Ad. Shell moderately thick, with very numerous, transverse ribbings, base distinctly keeled at the periphery, lip thin. *S. acuminata*, Sowb. (lxvii, 48). East Indies.

CONSTANTIA, A. Ad. Acuminately oval, spire elate, whorls rounded, the last ventricose, decussated by thin longitudinal plications and revolving elevated liræ; aperture oval, its continuous margin free, acute. *S. elegans*, A. Ad. (lxvi, 41). Korea.

SCALIOLA, A. Ad. Animal with proboscidiform head; rostrum elongated, cylindrical, annulated; tentacles filiform; eyes prominent, black, at the external base of the tentacles; foot short, oval, acuminated behind. Operculum corneous, oval, subspiral, with subterminal nucleus. The shell agglutinates to its spire particles of sand, etc. *S. bella*, A. Ad. (lxvi, 44). Japan.

FAMILY IANTHINIDÆ.

Shell globular-turbinate, thin. No operculum. Animal pelagic, sustained by a vesicular natatory apparatus, called the float, and to which the eggs are attached (xvii, 99). Dentition (xi, 35).

IANTHINA, Lam.

Etym.—*Ianthina*, violet-colored.

Distr.—10 sp. Atlantic and Pacific Oceans. *I. communis*, Lam. (lxvii, 49; xvii, 99).

Shell thin, translucent, trochiform; nucleus minute, styliform; sinistral; whorls few, rather ventricose; aperture four-sided; columella tortuous; lip thin, notched at the outer angle. Base of the shell deep violet, spire nearly white.

Animal. Head large, muzzle-shaped, with a tentacle and eye-pedicel on each side, but no eyes; foot small, secreting a float composed of numerous cartilaginous air-vesicles, to the under surface of which the ovarian capsules are attached. Lingual ribbon, rachis unarmed; uncini numerous, simple (like Scalaria). Branchial plumes two. Sexes separate.

The Ianthinæ, or oceanic-snails, are gregarious in the open sea, where they are found in myriads, and are said to feed on the small blue acalephæ (Velella). When handled they exude a violet fluid from beneath the margin of the mantle. In rough weather they are driven about and their floats broken, or detached, in which state they are often met with. The capsules beneath the farther end of the raft have been observed to be empty, at a time when those in the middle contained young with fully formed shells, and those near the animal were filled with eggs. They have no power of sinking and rising in the water. The raft, which is much too large to be withdrawn into the shell, is generally thought to be an extreme modification of the operculum; but M. Lucaze-Duthiers, who has seen the raft formed, denies this. It is built up from glutinous matter secreted by the foot.

RECLUZIA, Petit.

Etym.—Named in honor of Recluz, a French naturalist.

Distr.—2 sp. Red Sea, Atlantic, Mazatlan. *R. Rollandiana*, Petit (lxvii, 50).

Shell paludiniform, thin, with a brown epidermis; whorls ventricose; aperture ovate-oblique, slightly effused at the base, margins disunited; inner lip oblique, rather sinuated in the middle; outer lip acute, entire. No operculum.

Animal pelagic, resembling Ianthina, and like it provided with a vesicular float.

SCALITES, Conrad.

Distr.—Silurian; United States. *S. angulatus*, Conr. (lxvii, 51).

Shell turriculated, whorls flattened above, angulated at the shoulder, and convex below; outer lip sinuous; umbilicus none, or very small.

RAPHISTOMA, Hall. Shell turbinated, depressed, flattened and angulated above, convex below; aperture subtrigonal, columellar lip excavated in the middle and produced to the right below. *S. staminea*, Hall (lxvii, 52).

HOLOPEA, Hall. (Cyclora, Hall.) Is a palæozoic group composed of incongruous elements. Its first species has been referred to Littorinidæ, another evidently belongs to Naticidæ, a third resembles Ianthina. The species are mostly casts. There appears to be no good reason for retaining the group.

FAMILY TRICHOTROPIDÆ.

Shell thin, turbinated, carinated, the ridges with epidermal fringes, in fresh or living specimens; columella obliquely truncated. Operculum lamellar, nucleus external.

Animal with a short, broad head; tentacles distant, with eyes on the middle; proboscis long, retractile. Dentition, central teeth single, hamate, denticulated; uncini three on each side, of which the inner is denticulate, the others simple.

TRICHOTROPIS, Brod.

Etym.—*Thrix* (trichos), hair, and *tropis*, keel.

Syn.—Verena, Gray. Tropiphora, Lovén. Ariadna, Fischer. Trichophore, Desh.

Distr.—15 sp. Circumboreal. *T. borealis*, Gould (lxvii, 53). Fossil. Cret.—.

Characters those of the family.

IPHINOË, H. and A. Adams. Shell widely umbilicate, aperture subtriangular. *T. unicarinatus*, Sowb. (lxvii, 54).

ALORA, H. Adams. Shell ovate-fusiform, slightly umbilicated, thin; spire elevated; whorls convex, cancellated with elevated spiral ribs and thin lamellæ; aperture oval, slightly produced in front; inner lip smooth, rounded, slightly reflexed at the forepart; outer lip simple, acute. *T. Gouldii*, A. Ad. W. Coast Central Am.

GYROTROPIS, Gabb. Cretaceous; North Carolina. Shell thin, resembling Trichotropis in form; spire elevated; umbilicus widely open, funnel-shaped; last whorl angulated above and below the periphery; covered with very thin foliated longitudinal varices. *G. squamosus*, Gabb.

FAMILY TURRITELLIDÆ.

Rostrum short, broad; tentacles long and subulate, the eyes slightly prominent on their external bases. Mantle with a fringed margin, obscurely siphonated at the right side; branchial plume single, very long. Foot very short, truncate in front, rounded behind, grooved beneath; operculigerous lobe simple.

Shell spiral, not umbilicated, spire very long, of numerous whorls, with revolving striæ or carinations. Operculum corneous, multispiral.

TURRITELLA, Lam.

Screw-shell. *Etym.*—Diminutive of *turris*, a tower.

Syn.—Turris, Humphrey. Xylohelix, Chemn.

Distr.—73 sp. World-wide. Ranging from the Laminarian Zone to 100 fathoms. West Indies, United States, Britain (1 sp.), Iceland, Mediterranean, West Africa, China, Australia, West America. Fossil, 172 sp. Triassic—; Britain, etc., N. and S. America, Australia, Java. *T. terebra*, Linn. (lxvii, 55).

Shell elongated, many-whorled, whorls rounded with revolving striæ; aperture rounded. Operculum many-whorled, with a fimbriated margin. The shells are usually brown, with red-brown spots or flames.

TURRITELLOPSIS, Sars. Shell like Turritella, but the lingual dentition differs. A boreal group, doubtfully distinct. *T. acicula*, Stimpson (lxvii, 56).

HAUSTATOR, Montfort. Whorls flattened, mouth subquadrangular, outer lip sinuous. *T. goniostoma*, Val. (lxvii, 57).

TORCULA, Gray. Shell turriculated, usually white or horncolor, without markings; whorls subangular, with a median excavation; aperture subquadrangular, the outer lip with a slight median sinus. *T. cochlea*, Reeve (lxvii, 58).

ZARIA, Gray. Shell turriculated, without color-markings, whorls carinated; aperture subquadrangular, outer lip simple. *T. duplicata*, Linn. (lxvii, 59).

MESALIA, Gray. Shell turriculated, of numerous whorls; aperture oval, subcircular, slightly produced, with sinuous and reflected anterior margin; inner lip a little twisted and flattened, outer lip thin, sinuous posteriorly. *T. melanoides*, Reeve (lxvii, 60).

EGLISIA, Gray. Whorls rounded, with profound sutures; aperture rounded, rather small, inner lip flattened, callous, angular,

not reflected in front, outer lip somewhat thickened within. *T. lanceolata*, Reeve (lxvii, 61).

MATHILDA, Semper, 1865. Shell turriculated, apex revolute, abruptly turned from left to right; whorls in the typical species transversely cingulated and reticulated, longitudinally striated; aperture entire, subrotund, base sometimes subeffuse; lip acute; columella smooth. *T. cochlæformis*, Brugn. (lxvii, 62). Mediterranean; and several fossil species. Jurassic—; Europe, United States.

GLAUCONIA, Giebel, 1852. Shell turriculated, subulate; aperture small, rounded, peristome continuous, forming a posterior angle. Fossil. *T. Maraschini*, Defrance (lxvii, 63).

CASSIOPE, Coquand, 1866. (Omphalia, Zekeli, 1852 [not Omphalius, Phil.]. Proto, authors, not Defrance.) Shell thicker, and with more rapidly increasing whorls than in Turritella, often pupiform; aperture rounded, continuous; outer lip notched or sinuated by an impressed furrow, which winds round the last whorl; columella usually distinctly umbilicated. There are 30 cretaceous species. Europe, India and America. *C. Renevieri*, Coquand.

ARCOTIA, Stoliczka, 1868. Shell turreted, elongated, somewhat thickened; whorls spirally striate; incremental striæ straight, not sinuated; columella excavated; aperture angulately rounded, subeffuse anteriorly. *T. Indica*, Stol. (lxvii, 64). Jurassic and Cretaceous; India.

PROTOMA, Baird, 1870.

Distr.—*P. Knockeri*, Baird. Whydah, W. Africa.

Shell turreted, aperture oval, narrowly excised at the base. Operculum circular, corneous, multispiral.

The operculum shows this to belong to the Turritellidæ, although the aperture of the shell is more like that of Terebra.

LITHOTROCHUS, Conrad.

Approaching Mesalia, but without the produced basis of the last whorl of that genus. There is a thickened sutural band, with very numerous growth-striæ. Has much the appearance of an elongated Trochus. Liassic. *L. Humboldtii*, Buch. (lxvii, 65, 66). South America.

COCHLEARIA, Münster.

Syn.—Chilocyclus, Braun.

Distr.—2 fossil sp. Triassic; Austria. *C. carinata*, Bronn (lxvii, 67).

Shell turriculated, thick; aperture rounded, peristome continuous, widely and flatly reflected all around.

Zittel considers this a group in the family Scalaridæ.

Family VERMETIDÆ.

Animal with rudimentary foot, head long, with two long conical tentacles, and eyes at their outer bases; proboscis retractile; on the sides of the buccal orifice are additional tentacles or buccal appendages, also conical. Operculum circular, sometimes spiral.

Shell tubular, attached; sometimes regularly spiral when young; always irregular in its adult growth; tube repeatedly partitioned off; aperture round.

The Vermetidæ are distinguished from the very similar shells of the annelid genus Serpula by the presence of a spiral, nuclear shell and of concave smooth interior septa. The shell of Serpula is composed of two calcareous layers, that of Vermetidæ of three.

Vermetus, Adanson.

Shell irregularly spiral, or contorted tubular; free, or attached by one side like some of the annelids; operculate.

The following subgenera were considered distinct genera by Mörch:

VERMICULUS, Lister. (Vermetus of authors, not Adanson.) The shell is in its early stage regularly coiled like a Turritella, and afterwards with the last whorl uncoiled, variously twisted, or more or less straight and prolonged. There is apparently no other distinction between the shells of Vermiculus and Burtinella, except that the latter are coiled in a broad, largely umbilicated cone. 15 sp. Carboniferous—living. Tropical and subtropical. *V. lumbricalis*, Linn. (lxvii, 68).

BURTINELLA, Mörch. (Mörchia, Mayer.) Adult shell free, young affixed, thick, widely conically elevated, trochiform or planorboid, usually sinistral, rarely dextral; whorls regularly increasing in size, tubular within, angular without; the last whorl dissolute, more or less prolonged, not constricted; aperture circular, margin continuous. Fossil, 15 sp. Oolitic, Cretaceous, Tertiary; Europe, India. *B. concava*, Stol. (lxvii, 69, 70).

STREPHOPOMA, Mörch. Adult shell affixed, solitary or clustered; aperture slightly inflexed above, very obsoletely effused below. Operculum arctispiral, furnished with long multifid setæ. Recent, 4 sp. *S. rosea*, Quoy (lxvii, 71). The shells are generally very small, and usually so tender as to be very rarely found fossil in a good state of preservation. Difficult to distinguish from Vermiculus.

TUBULOSTIUM, Stoliczka. Shell free, planorboid to broadly conical, aperture contracted, prolonged in a tube. 4 sp. Jurassic; Europe. Tertiary; United States. Cretaceous; India. *T. callosum*, Stol. (lxvii, 72, 73).

SIPHONIUM, Browne. (Stoa, M. de Serres.) Shell adherent,

irregularly twisted, carinated. Operculum large, smoo
lar, concave; the scar of attachment central, rugose
World-wide. M. Rougemont has observed at Naples
S. maximum (lxvii, 74) emits from its mouth a thin
plaited substance, which entangles small natatory ani
is subsequently withdrawn.

VERMETUS, Adanson. (Macrophragma, Carp. Alete
Shell mostly spirally twisted, affixed, usually decussat
mella folded. Operculum thin, concave, scarcely spi
Vermetus of most authors is the Vermiculus of Lister
Widely diffused. *V. carinatus*, Quoy (lxvii, 75).

PETALOCONCHUS, Lea. An American tertiary fossil. S
two internal ridges running spirally along the columella, l
obsolete near the apex and aperture. *V. sculptura*
(lxvii, 76).

THYLACODES, Guettard. (Serpulorbis, Sassi. Lementi
Hatina, Gray. Cellularia, Schmidt. Cladopoma, Gray
nemia, Mörch.) Shell tubular, irregularly twisted,
aperture rounded, columella not plicate. No operc
minute when present. The animal has a truncated
duced in front into tentacular processes. Many li
several tertiary species; and one cret.; India. *T. arena*
(lxvii, 77).

BIVONIA, Gray. Shell affixed, mostly spiral, aperture co
circular, with spiral, interruptedly nodulose liræ, and
elevated line; columella smooth. Operculum small, rudi
Animal with cylindrical tentacles, pedal filaments su
setaceous. 7 sp. *B. triquetra*, Bivona (lxvii. 80). When
are not perfect with the margin of the aperture, they
difficult to distinguish from Spiroglyphus.

SPIROGLYPHUS, Daudin. Animal forming a groove
surface of shells or stones, covering it over with shell
and forming a tubular case. Many zoologists con
Spiroglyphus to be an annulose animal allied to Serpu
this there is no positive proof. The young animal, w
hatched, is covered with an ovate, regular shell, consis
whorl and a half; it soon attaches itself to the surface
stone or other shell, in which it forms a canal, at first
but afterwards deeper. *S. spirorbis*, Dillw. (lxvii, 78).

SILIQUARIA, Brug.

Etym.—*Siliqua*, a pod. *Syn.*—Tenagodus, Guettard
Distr.—15 sp. Mediterranean, Australia. Fossil, 20
tiary. The typical species, as well as several othe
imbedded in sponges. *S. anguina*, Linn. (lxvii, 79).

Shell tubular; spiral at first, afterwards irregular;
a continuous longitudinal slit. Operculum spiral, lik

Torinia, composed of a spiral band ciliated at the margin, forming a cylinder or cone, the axis of which is filled up by a series of spiral radiating cells.

PYXIPOMA, Mörch, 1860. Slit closed by a lamella, but not filled up outside. *S. lacteus*, Lam. Australia.

AGATHIRSES, Montf., 1810. The band composed of numerous isolated holes. Chiefly fossil. *S. squamosa*, Lam.

CRYPTOBIA, Desh. Proposed for a tubular shell, with spiral commencement, formerly supposed to be constructed by an annelid. It is believed to be related to Pyxipoma by Mörch, but its true nature is by no means clearly established. *S. Michelini*, Desh. Isle of Bourbon.

FAMILY CÆCIDÆ.

Shell with a fugatious spiral nucleus; tubular, regular, minute. Operculum horny, multispiral, margin sometimes fimbriated.

Animal. Lingual membrane short; teeth in two series (2·0·2), central denticles none, the lateral uncini with the inner one broad and serrulated. Rostrum long and flat; tentacles short, subclavate at the tips; eyes sessile behind the bases of the tentacles. Mantle thick, fleshy, circular, closely embracing the neck; a single branchial plume. Foot short, narrow, truncate in front, obtuse behind. Not at all shy, progressing with great vivacity.

CÆCUM, Fleming.

Syn.—Anellum, Carp. Cæcalium, Macg. Odontidium, Phil. Fartulum and Elephantulum, Carp. Brochina, Gray. Corniculina, Munster. Brochus, Browne. Odontina, Zborzewsky. Dentaliopsis, Clark. Odontidium, Phil.

Distr.—42 sp. Europe, United States, West Indies, Mazatlan, Australia, Japan, Mauritius. Fossil, 8 sp. Eocene—. *C. cornuoides* (lxvii, 81). *C. pulchellum*, (lxvii, 82).

Young shell spiral in one plane, afterwards an arcuated tube, truncated posteriorly by the loss of the spiral portion, and closed there by a convex septum.

P. P. Carpenter proposed subgenera for species distinguished by differences of sculpture, but M. de Folin, who has recently studied the Cæcidæ, points out that these groups are not founded on permanent characters, the various species exhibiting a series from smooth to ribbed surfaces.

BROCHINA, Gray. Founded on a single species, and insufficiently characterized by its convex operculum.

MIOCERAS, Carpenter, 1858. Young shell loosely spiral, not in one plane; adult shell somewhat inflated, aperture oblique; operculum externally concave. The species are all smooth, the adult resembling in shape the horn of an ox. *C. cornucopiæ*, Carp.

STREBLOCERAS, Carpenter, 1858. Shell not decollated, the permanent nucleus lying in a plane perpendicular to the adult tube. *C. cornuoides*, Carp.

PARASTROPHIA Folin. (Moreletia, Folin.) Nuclear whorls subspiral in one plane, as in the typical group, but persistent; tube inflated anteriorly.

FAMILY EULIMIDÆ.

Animal having slender, subulate, simple tentacles, with eyes sessile at their outer bases; mantle enclosed, with rudimentary siphonal fold; foot linguiform, produced in front.

Shell turriculated or turbiniform, smooth, milk-white, polished; aperture oval or rounded, sometimes angular in front; columella without plications. Operculum, when present, corneous, subspiral.

EULIMA, Risso.

Etym.—*Eulimia*, ravenous hunger.

Syn.—Pasithea, Lea (in part).

Distr.—49 sp. Britain, Mediterranean, India, Australia, Pacific. In 5–90 fathoms water. Fossil, 40 sp. Carb.?—; Britain, France, etc. *E. tortuosa*, Ads. (lxviii, 83).

Shell small, white, and polished; slender, elongated with numerous level whorls, spire often curved to one side; obscurely marked on one side by a series of periodic mouths, which form prominent ribs internally; apex acute; aperture oval, pointed above; outer lip thickened internally; inner lip reflected over the pillar, not umbilicated. Operculum horny, subspiral.

Animal, tentacles subulate, close, with the eyes immersed at their posterior bases; proboscis long, retractile; foot truncated in front, mentum bilobed; operculum lobe winged on each side; branchial plume single; mantle with a rudimentary siphonal fold.

The Eulimæ creep with the foot much in advance of the head, which is usually concealed within the aperture, the tentacles only protruding.—FORBES.

APICALIA, A. Adams, 1862. Apex more mucronated, spire more distorted. *E. gibba*, A. Ad. Japan.

EULIMOPSIS, Brugnone. Shell small, fusiformly turreted, subacute; base striate, whorls scarcely convex, with superficial sutures; aperture rhombovate, lip sinuous, columella contorted. *E. Carmelæ*, Brugnone (lxviii, 84). Pliocene; Sicily.

ARCUELLA, Nevill. (Bacula, H. and A. Adams.) Differs from the typical Eulima by having spiral striæ, and the columella twisted back so as to form an acute angle at the base of the aperture. *E. mirifica*, Nevill (lxviii, 85). Mauritius.

IOPSIS, Gabb. Differs from Eulima in its faintly twisted columella, which is produced in front so as to form a short,

though not notched canal. *E. fusiformis*, Gabb (lxviii, Tertiary; W. I. The existence of a sutural band shows group to be properly placed in Eulimidæ.

LEIOSTRACA, H. and A. Adams.

Syn.—Balcis, Leach.

Distr.—A few subtropical species. W. Indies, Mazatlan *L. subulata*, Donov. (lxviii, 87).

Shell subulate, turriculated, whorls a little flattened, sm polished, a slight varix on each side of the spire; ape oblong, entire; inner lip distinct, callous, a little sinuous i middle, outer lip flexuous.

MUCRONALIA, A. Ad. Shell subulate, straight, pupoidal, apex mucronate; whorls simple, aperture oblong. *Distr.*— *L. exilis*, A. Ad. Japan.

SELMA, A. Ad. Shell oblong-ovate, subdiaphanous, spire s last whorl large; aperture elongately ovate, columella arc obliquely subplicate. 1 sp. Japan.

EUCHRYSALIS, Laube, 1866.

Distr.—6 sp. Fossil. Jurassic, Cretaceous; Europe, I *E. bisulcata*, d'Orb.

Differs from Leiostraca by being pupoid, attenuated tow each end and thickened in the middle; last whorl large, r contracted posteriorly, aperture proportionally very s Surface generally smooth; inner lip somewhat thickened arcuate, outer lip sharp, sinuous.

[PUTILLA, Adams.

Shell turbinate, solid, pellucid; aperture subquadrate, riorly subeffuse, inner lip straight, thickened, columella ri I have arranged this genus in Rissoidæ, but it may belong h

NISO, Risso.

Syn.—Bonellia, Deshayes. Janella, Grateloup.

Distr.—China, W. America. Fossil. Cretaceous; Eoce Paris. *N. goniostoma*, Ads. (lxviii, 88).

Shell turriculated, smooth, polished, apex very sharp; u icus perforated or wide; aperture small, angulated above below.

OBINA, A. Ad. Shell conoidal, profoundly umbilicated, w thin, smooth, whorls flattened, aperture subquadrate, wi single columellar plait.

PALÆONISO, Gemm., 1878. Shell long, oval, cylindrical, c lip with a posterior sinus. *N. pupoides*, Gemm. Lias.

CLIMACINA, Gemm., 1878. Turreted, without umbilicus, whorls scalariform, mouth oval, angular behind, rounde front. *N. Catharinæ*, Gemm. Lias.

VOLUSIA, A. Ad., 1861. Shell longitudinally ribbed. *N. imbricata*, Sowb.

STYLIFER, Brod.

Syn.—Stylina, Gray.

Distr.—20 sp. Europe, West Indies, Polynesia, Philippines. *S. subulatus*, Brod. (lxviii, 89).

Shell hyaline, pellucid, thin, globular or subulate, smooth, polished; whorls numerous; apex very sharp, sometimes bent, nucleus sinistral; aperture suboval, angulated posteriorly, rounded in front; inner lip smooth, arcuated; outer lip slightly sinuous, thin, simple. No operculum.

Tentacles slender, subulate, simple, eyes sessile at their outer bases. Mantle enclosed. Foot linguiform, forming an elongated anterior lobe, rudimentary behind.

These singular animals are found among the species of Echinus, and in the skins of star-fishes, etc., burrowing beneath the surface, and producing tumors, often of considerable size. When removed and placed in water, they do not appear to possess much locomotive power, but extend the tongue-shaped foot and use it as an exploring organ. They were formerly believed to be parasitic, but are now thought to receive their food in the sea-water. Tongue unarmed.

The foot of Stylifer is much more produced anteriorly than that of Eulima: the shells have more globose whorls, and are generally thinner.

CYTHNIA, Carpenter. Imbedded in star-fishes like Stylifer, from which it is distinguished by its normal nuclear whorls, and thin concentric operculum. *S. tumens*, Carp. 3 sp. W. Coast of N. America.

PLICIFER, H. Ad. Imperforate, ovately subulate, not shining; spire styliform, nucleus sinistral, columella plicate; lip flexuous, sinuate behind, aperture entire in front. Found by Mr. Hugh Nevill on coral, at Ceylon; in texture resembles the shell of Leptoconchus. *P. Nevilli*, H. Ad. (lxviii, 90). Ceylon.

ENTOCONCHA, J. Müller.

Distr.—*E. mirabilis*, J. Müller.

Shell obovate, smooth; spire short, very obtuse, apex not elevated, whorls rapidly increasing; aperture transverse, semilunar, angulated above, rounded below, width almost equaling the height, margins disunited, the columellar margin straight. Operculum non-spiral.

Found parasitic on *Synapta digitata*, one of the I[illegible] [illegible]dæ, at Trieste. This is possibly the larval stage of so[illegible]

MACROCHEILUS, Phillips.

Etym.—*Macros*, large, and *cheilos*, lip.

Syn.—Polyphemopsis, Portlock. Amaurella, [illegible] stylus, Conrad. Macrochilina, Bayle, 1880.

Distr.—Several sp. *M. Japonicus.* Japan. Fossil, 12 sp. Devonian to Carboniferous; Britain, Belgium, United States. *M. Schlotheimii*, d'Arch. (lxviii, 91).

Shell thick, ventricose, buccinoid; aperture simple, effuse below, outer lip thin, inner lip wanting, columella callous, slightly tortuous.

I follow Woodward in making Polyphemopsis a synonym of this genus; but it is a very doubtful fossil, the surface of the type being worn off.

PASITHEA, Lea (restricted), 1833. Spire short, last whorl ventricose. Rather more slender and cylindrical than the typical Macrocheilus. *M. Claibornensis*, Lea. Eocene; Ala.

SUBULITES, Conrad, 1842.

Distr.—12 sp. Palæozoic; N. Am. *S. elongata*, Conrad.

Shell smooth, resembling a very mueh elongated Terebellum, but the exact form of the aperture is unknown. If this be really rounded and entire in front, the genus may be placed in this family; in the contrary case it may belong to the Pyramidellidæ or possibly to the Alata.

STROBEUS, Koninck, 1881.

Distr.—3 sp. Carb.; Belgium.

Shell small, long oval, smooth; spire pointed, of 5-7 convex whorls; mouth long oval, outer lip sharp; inner lip callous, with an anterior fold.

HOPLOPTERON, Fischer.

Distr.—*H. Terquemi*, Fischer (lxviii, 93). China Sea.

Shell imperforate, elongate-turreted, shining, apex obtuse; upper whorls plain, lower ones with triangular, flat, projecting wings on each side; aperture entire, the margin acute, columella without plaits.

Probably an embryonic shell (?). It is only 1·15 mill. long.

SUBEULIMA, Souverb.

Distr.—*S. Lamberti*, Souverb. (lxviii, 94). New Caledonia.

Shell turreted, elongated, whorls numerous, angulated and carinated in the middle; spire tortuous as in Eulima

SCALENOSTOMA, Deshayes.

Distr.—*S. carinatum*, Desh. (lxviii, 95). Isle of Bourbon.

Shell in form allied to Pyramidella and Niso, turriculated, white. imperforate; columella not plicated; opening subtriangular, slightly bent in the direction of its length; margin simple, notched near the suture.

BULIMORPHA, Whitfield, 1882.

Syn.—Bulimella, Hall (not Pfeiffer). Polyphemopsis, Portlock, in part.

Distr.—3 sp. Carb.; Indiana. *B. bulimiformis*, Hall.

Shell fusiform, spire produced; volutions convex, the last large; columella bent and truncated at the base, where it is separated from the outer lip by a notch, as in the recent genus Achatina; outer lip very slightly notched near the upper end; surface of the shell smooth.

CHEMNITZIA, d'Orb., 1850.

Etym.—In honor of Chemnitz, a distinguished Nuremburg conchologist, who published seven volumes in continuation of Martini's "Conchylien Cabinet," 1780–1795.

Distr.—Fossil only, 250 sp. World-wide. Triassic—. *C. condensata*, Desh. lxviii, 96).

Shell comparatively large, elongate-conical; spire many-whorled, not reversed at the apex; last whorl moderately large, somewhat produced below; aperture ovate, sometimes faintly effuse at base; peritreme not continuous; outer lip sharp, with usually a faintly sinuous outline near or above the middle; columella smooth; imperforate; surface with longitudinal costæ or lines, sometimes crossed by revolving striæ—rarely nodular.

I restrict Chemnitzia to the fossil group so known, and which appears to have been most nearly related to the Eulimidæ. The much smaller sized ribbed recent species which have been referred to this genus, and which d'Orbigny actually included in his earliest definition of it, are distinguished under the name of Turbonilla, Risso. They do not possess the broad posterior insinuation of the outer lip characteristic of Chemnitzia.

CHEMNITZIA (restricted). Shell lengthened with cross-ribs; mouth oval, rounded or angular in front; spire straight or slightly curved, somewhat callous; outer lip sharp. *Ch. similis*, Münst.

RHABDOCONCHA, Gemmellaro, 1878. Whorls striate or ribbed longitudinally, which are sometimes punctate or tuberculate. *C. crassilabrata*, Terq.

PSEUDOMELANIA (Pictet), Gemmellaro, 1878. Shell long, thick; whorls smooth, with fine curved growth-lines; mouth rounded or angular in front; spire straight or slightly curved. *Ch. Normannia*, d'Orb.

OONIA, Gemmellaro, 1878. Shell egg-shaped, smooth, with growth-lines; last whorl large; mouth oval, rounded in front; spire slightly curved. *Ch. Cornelia*, d'Orb.

MICROSCHIZA, Gemmellaro, 1878. Shell usually with cross-ribs; narrowly perforated; whorls sharp, mostly scalariform; mouth oval, rounded in front; inner lip and spire callously thickened. *C. Philenor*, d'Orb.

LOXONEMA, Phillips.

Etym.—*Loxos*, oblique, and *nema*, thread; in allusion to the striated surface of many species.

Syn.—Michelia, Römer. Holopella, Sandb. (in part).

Distr.—Fossil, 75 sp. L. Silurian—Trias; North America Europe. *L. costatum*, Sandb. (lxviii, 97).

Shell elongated, many-whorled; aperture simple, attenuate above, effused below, with a sigmoidal edge to the outer lip.

Like many other palæozoic genera, the bad condition of man of the species and the variation in form and sculpture render i difficult to place it properly in a systematic work; some of th species might go into Turbonillidæ, others appear closely allie to Chemnitzia, and might even be synonymous with it.

Orthonema, Meek and Worthen, 1861.

Distr.—Several fossil species. Devonian, Carboniferous; U. S *O. Salteri*, Meek.

Shell elongate, many-whorled; volutions ornamented wit revolving carinæ, crossed by nearly straight lines of growth body-whorl not produced below; aperture angular above, slightl effuse below; peristome incomplete; lip simple, nearly straight axis imperforate.

Differs from Turritella in its slightly effuse and less rounde aperture, disconnected peristome, and straight outer lip. It i probably more nearly allied to Loxonema, but has distinc revolving carinæ, and wants the sigmoid outer lip of that genus

Bourguetia, Desh.

Distr.—*Phasianella striata*, Sowb., etc. Jurassic.

Shell large, turreted; spire long, pointed; whorls convex spirally striated or grooved; last whorl large; mouth oval angular behind, widened and rounded in front.

Family TURBONILLIDÆ.

Animal with a short head, triangular tentacles, and eyes a their outer bases; proboscis long, retractile; foot truncated i front.

Shell white, slender, elongated, many-whorled, mostly longi tudinally ribbed or spirally striate. Operculum horny, sub spiral.

The animal differs from that of Eulimidæ and resembles that o Pyramidellidæ, but the shell is, in the recent species, usuall more slim than Pyramidella, and without columellar folds, o with a single small fold. It differs from Eulima in being sculp tured.

Most of the recent species are of quite small size.

Turbonilla, Risso.

Syn.—Chemnitzia, d'Orb., 1839, not 1850. Pyrgiscus, Phil Orthostelis, Arad.

Distr.—50 sp. World-wide. Range from low-water to 90 fathoms. Fossil. Cretaceous—. *T. elegantissima*, Mont. (lxviii, 98).

Shell slender, elongated, many-whorled; whorls plaited; apex sinistral; aperture simple, ovate; peristome incomplete, columella not plaited. Operculum horny, subspiral.

Animal. Head very short, furnished with a long, retractile proboscis; tentacles triangular; eyes immersed at the inner angles of the tentacles; foot truncated in front, with a distinct mentum, operculigerous lobe with a minute conical appendage on each side.

Comprises a great number of small, graceful white shells which have been grouped in a number of genera or subgenera.

MORMULA, A. Ad. Subulately-turreted, rissoid, solid, thick, longitudinally plicate; aperture large, columella spirally tortuous, lip thickened within, margin acute. A few Japanese species. *T. rissoina*, A. Ad.

DUNKERIA, Carpenter, 1857. (In honor of W. Dunker, a distinguished German conchologist.) Whorls rounded, cancellated. Numerous species. Mazatlan, Japan. *T. paucilirata*, Carp. Mazatlan.

VANESIA, A. Ad., 1861. Proposed for two species resembling Melania in external characters, but true marine shells, decussated by longitudinal and spiral ridges. *T. trifasciata*, Sowb. China.

SPIROCLIMAX, Mörch. Subcylindrical, pellucid, suture contabulate, aperture ear-shaped, lip thickened, sigmoidal, subemarginate, inflexed at the suture. 1 sp. West Indies.

MIROBELI-CUS, Sandb. *T. inaspecta*, Fuchs.

STREPTACIS, Meek, 1871.

Distr.—*S. Whitfieldi*, Meek. Carb.; Ills.

Shell small, turreted, smooth; embryonal whorls planorbiform; mouth oval.

HOLOPELLA, M'Coy, 1852.

Etym.—'*olos*, entire, and *ope*, an aperture.

Distr.—Fossil, 12 sp. Silurian, Trias; Europe, United States. *H. gregaria*, Sowb.

Shell elongated, slender, of numerous gradually increasing whorls, generally crossed by slightly arched striæ; mouth circular, with the peristome entire; base rounded, with or without a minute umbilicus.

The shells of the species composing this genus differ from those of Turritella in the continuous peristome and definite round margin to the aperture, thus approaching much nearer to Scalaria.

EULIMELLA, Forbes.

Distr.—Eur., Japan. *E. Scillæ*, Scacchi (lxviii, 1, 2).

Shell elongated, turriculate, solid, smooth, polished, whorls

numerous, apex sinistral; aperture subquadrangular, lip not continuous, columella straight, not plicate.

STYLOPTYGMA, A. Ad., 1860. Shell inflated about the middle of the spire, thus becoming somewhat pupiform; smooth, or slightly ribbed. *E. stylina*, A. Ad. Japan.

ANISOCYCLA, Monts.

Syn.—Aciculina, Deshayes (not Ads.).

Distr.—6 sp. Eocene; Paris basin. *A. gracilis*, Desh. (lxviii, 100). Closely allied to Eulimella.

Shell small, aciculated; apex laterally inclined; whorls numerous, convex, smooth; aperture entire, small, subquadrangular; columella straight, narrow, cylindrical, and simple.

ACLIS, Lovén.

Etym.—*A*, without, *kleis*, a projection.

Syn.—Alvania, Leach (not Risso). Cælatura, Conrad. Cioniscus, Jeffreys. Pherusa, Jeffreys. Actæonema, Conrad.

Distr.—*A. nitidissima*, Mont. (lxviii, 92). Fossil, 12 sp. Devonian—; Europe, United States.

Shell minute, like Turritella; usually spirally striated; apex sinistral; aperture oval; outer lip prominent; axis slightly rimate. Operculate.

Animal with a long retractile proboscis; tentacles close together, slender, inflated at the tips; eyes immersed at the bases of the tentacles; operculum lobe ample, unsymmetrical; foot truncated in front.

EBALA, Leach. Shell smooth, rimate. *A. diaphana*, A. Ad.

HEMIACLIS, Sars. Shell glabrous, turreted, rimate, lip arcuate. Synonymous with Ebala (?). *A. ventrosa*, Jeffreys (lxviii, 99).

RISSOPSIS, Garrett. Shell small, thin, elongate, cylindrical; apex truncate; aperture subovate, angular above, entire; peristome rather thin, somewhat expanded; columella oblique, arched. *R. typica*, Garrett (lxviii, 3). Viti and Samoa Isles.

IOLÆA, A. Ad. Resembles Niso, but has a remarkably thin, spirally sulcated shell. Deep water. *I. scitula*, A. Ad. (lxviii, 4). Japan.

ODOSTOMIA, Fleming.

Etym.—*Odous*, a tooth, and *stoma*, mouth.

Syn.—Odontostoma, Phil. Odontostomia, Jeffreys.

Distr.—Species numerous, distribution universal, from low-water to 40 fathoms. Fossil, 15 sp. Eocene—. *O. nitida*, Alder (lxviii. 5.)

Shell subulate or ovate, typically smooth; apex sinistral; aperture ovate; peristome not continuous; columella with a single tooth-like fold. Operculum horny, indented on the inner side.

Animal elongated, the head large and robust, bearing two conical tentacles with eyes at their bases, foot depressed, truncated in front.

Very minute, usually smooth shells, having the habit of Rissoæ, and like them sometimes found in brackish water.

PARTHENIA, Lowe, 1863. (Pyrgulina, A. Ad.) Shell thin, turriculated, imperforate, usually milk-white under a very pale thin epidermis; whorls ribbed or striate, sometimes cancellate, vanishing at the periphery of the last whorl. 25 sp. Mazatlan, Japan. *O. monocycla*, A. Ad.

MIRALDA, A. Ad., 1863. Solid, ovate or elongated; whorls flat, plicate behind, transversely lirate in front; lip subangulate behind, margin crenate. Several Japanese species. *O. diadema*. A. Ad.

MUMIOLA, A. Ad., 1863. Shell thin, elongate or ovate; whorls convex, cancellate or granulose; aperture ovate, lip-margin regularly arcuate. 3 Japanese species. *O. spirata*, A. Ad.

AURICULINA, Gray. Shell oval, thin, bulimiform; whorls smooth or concentrically striate; columella not plicate. 6 sp. Mazatlan, Japan. Fossil, 4 sp. Tertiary; U. S. *O. cylindracea*, Alder (lxviii, 6). May possibly be a member of the family Actæonidæ.

LIOSTOMIA, Sars. Shell rimate, smooth; operculum paucispiral. 2 sp. Norway. *L. eburnea*, Stimpson (lxviii, 17, 18). Massachusetts.

CHRYSALLIDA, Carpenter. Shell pupiform, usually cancellated; peristome continuous; edge of lip thin; columella-plait distinct, though hidden; operculum in the typical species radiately corrugated. 25 sp. E. and W. Indies, Japan, Mazatlan. *O. communis*, C. B. Ad. (lxviii, 7).

DOLIELLA, Monts. Shell Doliiform, apex immersed.

PYRAMIS, Couthouy.

Syn.—Menestho, Möller. *Type.*—*P. striatus*, Couth. (lxviii, 8).

Shell turriculated or elongated, with revolving striæ; mouth oval, small; columella with a rudimentary plication, sometimes obsolete.

MONOPTYGMA, Gray (not Lea). Having a sinuous columellar plication. *P. casta*, Ads. (lxviii, 9).

CARELIOPSIS, Mörch. Shell turriculated, having the form of *Carelia Cumingii*.

OSCILLA, A. Ad.

Distr.—4 Japanese species. *Obeliscus annulatus*, A. Ad.

Shell solid, ovate or pyramidally turreted; imperforate; whorls strongly transversely lirate; aperture ovate or subquadrate; parietal plication strong, transverse, median.

ELUSA, A. Ad., 1861.

Distr.—China, Japan. *E. teres*, A. Ad.

Shell subulate, turreted; whorls longitudinally plicate; aperture ovate, inner lip with a single plait, outer lip frequently lirate within.

SYRNOLA, A. Ad., 1860.

Distr.—10 sp. Japan. *S. gracillima*, A. Ad.

Shell subulate, straight, vitreous, banded, polished; whorls flat, suture impressed; aperture oblong, inner lip obliquely plicate in the middle, outer lip simple, acute. They are readily distinguished from the more oval Odostomia—the species of which are white and destitute of colored markings. Syrnola, in fact, are small slender Obelisci with a single columellar plait.

AMATHIS, A. Ad., 1861. Subulate, smooth, polished, aperture dilated, rounded, acute behind, inner lip with a single plication. 6 sp. Japan. *S. Virgo*, A. Ad.

SYRNOLOPSIS, Smith.

Distr.—*S. lacustris*, E. A. Smith (lxviii, 15, 16). The only species, from Lake Tanganyika, E. Africa (fresh water), is yellowish horn-color, banded with white beneath the suture.

Shell subulate, smooth, imperforate; aperture broadly sinuated at the base, outer lip sinuous, slightly thickened, produced below, furnished far within with one or two prominent liræ; columella with a distinct plait. Operculum unknown.

FAMILY PYRAMIDELLIDÆ.

Shell turriculated, columella with several anterior plications. Operculum corneous, subspiral, the columellar margin sinuated.

Animal with broad-shouldered, ear-shaped tentacles, connate at the base; eyes immersed at their inner sides; mantle enclosed, with a rudimentary siphonal fold; foot produced and truncate anteriorly, with a fold or mentum in front. Lingual teeth none, or rudimentary.

The Turbonillidæ, just described, have been usually referred to this family, and in fact their distinction is one of convenience only, the number of columellar plications or their absence being characters of small importance.

"The Pyramidellidæ present subjects of much interest to the student of extinct mollusca; numerous forms, bearing all the aspect of being members of this family, occur among the fossils of even the oldest stratified rocks. Many of them are gigantic compared with existing species, and the group, as a whole, may be regarded rather as appertaining to past ages than the present epoch."—FORBES.

PYRAMIDELLA, Lam.

Etym.—Diminutive of *pyramis*, a pyramid.

Distr.—25 sp. W. Indies, Australia, Japan. *P. plicata*, Lam. (lxviii, 11). Fossil. Cretaceous.

Shell turriculated, spire elevated, longitudinally ribbed; columella with three anterior plications; outer lip sharp, sometimes plicate within.

The Pyramidellæ live in sandy bays and on shallow mud-banks, concealing themselves under the surface, and indicating their presence by the formation of slender raised tracks.

OBELISCUS, Humphrey. Differs from Pyramidella in being smooth instead of ribbed. *P. maculosa*, Lam. (lxviii, 12).

TIBERIA, Jeffreys. Shell umbilicated. *P. minuscula*, Monts. Deep Sea. Mediterranean.

LONCHÆUS, Mörch. Shell imperforate, last whorl with a median sulcus.

TRIPTYCHUS, Mörch. Shell subulate, paucilirate spirally; aperture lirate within; columella with three small anterior plications.

NERINÆA, Defrance.

Etym.—*Nereis*, a sea-nymph.

Syn.—Itruvia, Stolicz. Itieria, Matheron.

Distr.—Fossil, 150 sp. Jurassic, Cretaceous; Britain, France, Germany, Spain, and Portugal. They are most abundant, and attain the largest size to the south; and usually occur in calcareous strata, associated with shallow-water shells. *N. trinodosa*, d'Orb. (lxviii, 10). *N. trachea*, Desh. (lxviii, 13).

Shell elongated; many-whorled, nearly cylindrical; aperture channeled in front; interior with continuous ridges on the columella and whorls.

NERINÆA (restricted). Folds simple: 2–3 on the columella; 1–2 on the outer wall; columella solid, or perforated. Above 50 sp.

NERINELLA, Sharp. Columella solid; folds simple; columellar, 0–1; outer wall, 1.

TROCHALIA, Sharpe. Columella perforated, with one fold; outer wall simple, or thickened, or with one fold; folds simple.

PTYGMATIS, Sharpe. Columella solid or perforated, usually with 3 folds; outer wall with 1–3 folds, some of them complicated in form.

HALLOYSIA, Briart and Cornet. Shell elongated, turriculated, whorls numerous, axis widely perforated, aperture rounded or subquadrangular, columella biplicated. *H. biplicata*, B. and C. (lxviii, 14). Calcaire grossier of Mons, Belgium.

SOLENISCUS, Meek and Worthen, 1860.

Etym.—*Soleniskos*, a little channel or gutter.

Distr.—*S. typicus*. Upper Coal Measures; Springfield, Illinois.

Shell fusiform, smooth, body-whorl contracted below into a distinct straight canal, with an oblique plait on the columella.

Agrees with Macrocheilus in its smooth surface and columella-

fold, but differs in its fusiform outline, narrow aperture, and distinct canal. In its general appearance resembles Fasciolaria, but has only one instead of two or three columella-folds, and is destitute of ornamentation, and its outer lip is smooth within.

CRYPTOPLOCUS, Pictet and Campiche, 1854.

Etym.—*Cryptos*, hidden, *ploce*, a plait.

Distr.—7 sp. Jurassic and Cretaceous; France, Switzerland, Germany. *C. monilifera*, d'Orb.

Shell as in Nerinæa, without columella and labial plaits; one plait on the posterior face of the aperture, a disposition very analogous to that in some Cerithiums, such as *C. nodulosum;* aperture rounded, not channeled in front; umbilicated or imperforate.

APTYXIS, Zittel, 1873.

Syn.—Pachystylus, Gemmellaro, 1878.

Distr.—*A. sexcostata*, d'Orb. Jurassic.

Shell turreted, nearly cylindrical, not umbilicated; mouth lengthened quadrangular; inner and outer lips without folds; columella with a median fold-like thickening.

FAMILY LITTORINIDÆ.

Shell spiral, turbinate or globular; peritreme entire, interior not nacreous.

Operculum corneous, spiral or paucispiral.

Animal having a proboscidiform head with terminal mouth, and conical tentacles, subulate, with eyes at their outer bases.

The species inhabit the sea, brackish or fresh water, some being amphibious. They are mostly littoral, feeding on algæ. Dentition (xi, 26).

LITTORINA, Ferussac.

Etym.—*Littoralis*, belonging to the sea-shore. Periwinkle.

Syn.—Bacalia, Gray. Isonema, Hall (in part).

Distr.—175 sp. *L. littorea*, Linn. (lxix, 19). The periwinkles are found on the sea-shore in all parts of the world. In the Baltic they live within the influence of fresh water, and frequently become distorted in consequence; similar monstrosities are found fossil in the Norwich crag of England.

Fossil. Rather numerous; Miocene—. Probably some of the older fossils referred to Turbo, etc., belong to this genus.

Shell turbinated, thick, pointed, few-whorled; aperture rounded, outer lip acute, columella rather flattened, imperforate. Operculum paucispiral, lingual teeth hooked and trilobed; uncini hooked and dentated.

The foot is divided by a longitudinal line and in walking sides advance alternately. The periwinkle and trochus ar food of the thrush, in the Hebrides, during winter. The lir canal of the periwinkle passes from the back of the mouth u the œsophagus for a short distance, then turns up on the right and terminates in a coil (like spare rope) resting on the pl portion of the gullet. It is $2\frac{1}{2}$ inches long, and contains a 600 rows of teeth; the part in use, arming the tongue, comp about 24 rows.

The species above referred to, *L. littorea*, is an exceedi numerous mollusk of Northern Europe; it appears to become naturalized on the New England coast, where its is rapidly increasing. It is largely consumed as an article of in Europe, not only at the sea-ports and fishing villages, even at the great capitals; 1900 tons of it being sold ann in London and employing a thousand persons in gatherin It is also extensively used as bait, and to keep the oyster gro clear of sea-weed—for which purpose the Essex oystermen larly distribute many bushels of winkles over their grounds

Many of the large species, including the above and American species *L. irrorata*, Say, are in a great measure am ious, living on the rocks along the shore, where they are wa by the tide. Several individuals of a West Indian species vived deprivation of water for more than a year in my cal

MELARAPHIS, Muhlfeldt. Shell rather thin, conical, with po spire; surface with revolving striæ, and usually variegated brilliant colors. Tropical and subtropical. *L. angulifera*, (lxix, 20).

NERITOIDES, Brown. (Neritrema, Recluz.) Shell short t nated or subglobose; spire very short, with obtuse apex; inner lip much thickened and excavated. *L. obtusata*, (lxix, 21).

CYCLONEMA, Hall. Shell somewhat thinner than in the l Littorinæ. Palæozoic. 40 sp. U. S., Europe. *L. cance* Hall (lxix, 22).

RAULINIA, Mayer, 1864. Shell turbinate, ovate-oblong, r thin, spirally sulcate; aperture ovate-oblong, margin sin angulate behind, subeffuse in front; columellar lip wide, arc with a central tooth. Fossil. Paris basin. A living Austr species. *L. alligata*, Desh. (lxix, 23).

A large number of palæozoic, mostly smooth shells like P ostoma, Conr., Holopea, Hall, Macrocheilus, Phillips, etc., w are generally referred elsewhere, may very probably belo Littorinidæ.

Tectarius, Valenciennes.

Syn.—Monodonta (partim), Lam. Pagodus, Gray. Pagodella, Swains.

Distr.—Tropical. World-wide. *T. pyramidalis*, Quoy (lxix, 24).

Shell conical ovate or turbinated, surface tubercular or muricated, frequently angulated or biangulated on the middle of the last whorl; aperture striated within; axis usually imperforate. Operculum paucispiral, with a broad membranous border.

ECHINELLA, Swains. (Nina, Gray.) Depressed trochiform, more or less distinctly umbilicated. Operculum multispiral. *T. Cumingii*, Phil. (lxix, 25).

EUCYCLUS, Deslongchamps. (Amberleya, Morris and Lycett.) Shell very thin, spire elongated, almost turriculated; lip semicircular, thin; columella flattened; imperforate. 23 sp. Jurassic, Liassic; Europe. *E. obeliscus*, Desl. Amberleya has priority but is insufficiently characterized.

BRACHYTREMA, Morris and Lycett. Shell small, turreted, turbinated; whorls either costated, nodulated, or cancellated; the last whorl large and ventricose; columella smooth, rounded, twisted near its base, and reflected outwards, forming a short, oblique canal; aperture moderately subovate, its length being usually less than that of the spire. Some species, as *B. varicosa* and *B. pygmæa*, acquired at certain arrests of growth thickened outer lips or varices, as in Triton. 16 sp. Lias; Europe. This form has been referred to the Cerithiidæ, but its shape, aperture and sculpture all remind one of Tectarius; indeed, I doubt if it be really distinct from Eucyclus.

Modulus, Gray.

Distr.—10 sp. W. Indies, W. tropical America, Philippines. *M. tectum*, Gmel. (lxix, 27).

Shell top-shaped, spire depressed, ribbed or tubercular, rather thin; narrowly umbilicated; columella with an anterior curved tooth. Operculum spiral.

Animal with eyes on the middle of the tentacles.

Risella, Gray.

Distr.—10 sp. Australia. *R. melanostoma*, Gmel. (lxix, 28).

Shell depressed trochiform, with flattened whorls and keeled periphery; not umbilicated; aperture rhomboidal, marked with brown inside the margin. Operculum paucispiral.

These shells are distinguished from Trochus, which they resemble in form and sculpture, by their non-nacreous interior; the animal by eyes on the tentacles instead of on peduncles, and by the absence of the lateral membranes of the foot.

PLESIOTROCHUS, Fischer. Shell imperforate; conic-elongate, not varicose; whorls numerous; aperture subrhomboidal, smooth

within, not nacreous, prolonged into a short canal below; lip ubrostrated in the middle; columella edentulous. Operculum corneous, paucispiral. *R. Souverbianus*, Fischer (lxix, 29). New Caledonia.

LIMNOTROCHUS, E. A. Smith. Shell trochoid, umbilicated, without an epidermis, spirally ridged; aperture non-lirate within, with the outer lip oblique, the basal margin broadly sinuated, and the columella-edge somewhat reflexed and united to the labrum above by a callosity. Operculum horny, paucispiral. 2 sp. Lake Tanganyika, E. Africa. *R. Thomsoni*, E. A. Smith (lxix, 30). Remarkably like the genus Plesiotrochus described above; indeed it would be difficult to separate them, except by the locality; this, with other very curious forms imitating marine genera, occurs in fresh water, as above.

Microdoma, Meek and Worthen.

Distr.—*M. conica*, M. and W. (lxix, 26).

Shell small, rather thick, conical, imperforate, composed of flattened whorls, the last one of which is more or less angular around the middle and little produced below; aperture about as high as wide; outer lip simple, straight and oblique in outline; columella without folds or plications, inner lip thin and slightly reflected at the base of the columella. Surface with revolving nodular ridges.

Cyclocheila, Conrad.

Distr.—1 sp. Tertiary; So. America.

Pyramidal; aperture circular; labrum expanded, columella flattened, subangular at the base; periphery angular; a very doubtful little shell, probably fresh water.

Lacuna, Turton.

Etym.—*Lacuna*, a fissure. *Syn.*—Temana, Leach.

Distr.—16 sp. Northern shores, Norway, Britain, Spain, United States. Fossil. Eocene—. *L. pallidula*, Da Costa (lxix, 31).

Shell turbinated, thin; aperture semilunar; columella flattened, with an umbilical fissure; operculum paucispiral.

Animal. Operculigerous lobe furnished with lateral wings and tentacular filaments. Teeth 5-cusped; uncini 1, 2, dentated, 3 simple. Spawn vermiform, thick, semicircular. Range, low-water to 50 fathoms.

The Lacunæ feed upon sea-weed, and Lovén observes that when the fucus is of a brown color, the animals become green, but if red, they assume a rosy tint.

EPHERIA, Leach. Shell thin, with revolving colored bands; spire rather elevated; inner lip thin, sharp. *L. vincta*, Turton (lxix, 32).

MEDORIA, Leach. Shell conical, solid, with elevated spire; peritreme dilated, anteriorly reflected; inner lip thick, flattened; umbilical fissure obsolete. *L. turrita*, A. Ad. Japan.

ERSILIA, Monts. 1 sp. Mediterranean.

HELA, Jeffreys. (Cithna, Jeffreys.) Shell shaped like Lacuna with a similar operculum; but it has no epidermis; apex truncated or flattened, and instead of an umbilical canal or groove there is merely a narrow chink. Tentacles ciliated. *L. tenella* Jeffreys (lxix, 33). Europe.

Hela being preoccupied in another department of zoology Jeffreys changed the name to Cithna—already used by Mr. A. Adams for a somewhat similar shell. I restore the original designation. Mr. Jeffreys being already honored with a generic name in Conchology, I cannot pay him the compliment usually tendered those who apply preoccupied names to new forms.

STENOTIS, A. Ad., 1863. Shell compressed, elongately ovate, auriform; spire short, acute; whorls flattened, the last solute; aperture oblong, narrow behind, margin continuous, acute; umbilicus patulous, its margin angulate. *L. laxata*, A. Ad. Japan.

LACUNARIA, Conrad. Ovate-conoid or subglobose, thin, with delicate, close, revolving lines; aperture entire, rounded or round-ovate, angulated posteriorly, margins disunited; columella flattened, with a long groove descending from the umbilicus. Eocene; United States and France. *L. Alabamensis*, Whitfield (lxix, 34).

SPIRONEMA, Meek. (Callonema, Conrad.) Shell ovate; whorls rounded, and separated by a rather deep suture; aperture ovate, lip thin, continuous; columella not thickened, perforated by a very small umbilicus; surface with revolving lines and furrows. *L. tenuilineata*, Meek and Hayden (lxix, 35). Cretaceous; U. S.

LACUNELLA, Deshayes. Shell oval, thin, pellucid, shining, apex obtuse; aperture large, dilated, with thin, expanded margin; columella narrow, thin, concave, divided by a narrow channel, scarcely perforate at the base. *L. depressa*, Desh. (lxix, 36). Eocene; Paris basin.

CREMNOCONCHUS, Blanford.

Syn.—Cremnobates, Blanf., preoccupied in fishes.

Distr.—3 sp. India, upon rocks wetted by fresh water. *C. Syhadrensis*, Blanf. (lxix, 37, 38).

Shell perforate, turbinately globose, ribbed; aperture subovate, margin simple, columella scarcely callous. Operculum testaceous, paucispiral.

Animal small, having a short proboscis, two short tentacles with eyes on swellings at their outer bases, foot short and

rounded. The dentition corresponds with that of the Littorinidæ.

FOSSARUS, Philippi.

Syn.—Phasianema, Wood. Maravignia, Aradas. Megalomphalus, Brusina.

Distr.—43 sp., including species of the subgenera. Mediterranean, W. America, Polynesia, Japan, Red Sea. Fossil, 4 sp. Miocene; Europe. *F. costatus*, Brocchi (lxix, 39). *F. ambiguus*, Linn. (lxix, 40).

Shell perforated, sculptured; inner lip thin; aperture semilunate. Operculum not spiral.

Animal with two frontal lobes between the tentacles.

ISAPIS, H. and A. Adams. Shell umbilicated, spire elevated, cancellated or with revolving ribs, columella with a small median tooth (almost obsolete in *F. anomala*). 4 sp. West Indies, Mazatlan. *F. anomala*, C. B. Ad. (lxix, 41).

FOSSARINA, Adams and Angas. Aperture circular, inner lip arcuated. 2 sp. Australia. *F. patula*, Ad. and Angas (lxix, 41).

COUTHOUYIA, A. Ad., 1860. Shell ovate, profoundly and widely rimate; spire acuminate; whorls convex, decussated, with impressed sutures; aperture semiovate; inner lip straight, dilated in front, outer lip arcuate, simple. Japan. 3 sp. *F. decussata*, A. Ad.

CONRADIA, A. Ad., 1860. Shell turbinate, rimately umbilicate, spire somewhat elate; whorls convex, carinated concentrically; aperture round the outer margin fimbriate, inner lip without teeth; umbilicus margined by a semilunar rib. 6 sp. Japan. *F. cingulifera*, A. Ad.

GOTTOINA, A. Ad., 1863. Lirate, solid, imperforate. 2 sp. Japan. *F. sulcifera*, A. Ad.

CITHNA, A. Ad., 1863. Globosely turbinate, thin, whorls smooth, umbilicus margined. 2 sp. Japan. *F. globosa*, A. Ad.

FOSSARIOPSIS, Laube, 1870. Distinguished from Fossarus by the closed umbilicus and the callous expansion of the inner lip. *F. rugoso-carinata*, Klipst. Triassic.

TUBA, Lea. Shell conical, umbilicate; whorls rounded, cancellated; aperture rounded, margin not continuous above; columella thickened and reflected at the base. *F. alternata*, Lea (lxix, 43). Eocene; U. S.

ATRESIUS, Gabb, 1869.

Distr.—*A. liratus*, Gabb. Cret.; Cal.

Shell elongate, spire elevated; whorls rounded; aperture ovate, slightly produced in front, outer lip entire, thin; columella not callous, imperforate; surface marked by revolving ribs. Possibly belongs in Cerithiidæ.

FAMILY PLANAXIDÆ.

Shell oval-conic, spire elevated, spirally striate; columella flattened, anteriorly truncate; lip rounded, simple, notched in front. Operculum corneous, subspiral.

Animal with a rather long rostrum, subulate tentacles, and eyes on swellings at their base, foot short, plain in Planaxis, with tentacular filaments in Litiopa.

PLANAXIS, Lam.

Distr.—44 sp. West Indian, Indo-Pacific, Polynesian, Panamic. *P. sulcatus*, Lam. (lxix, 44). Fossil. Tertiary.

Shell oval-conic, solid, with elevated spire; usually spirally ribbed; columella callous, flattened, truncate at base, with a narrow sinus; interior of aperture ridged; base notched.

Amphibious, crawling on stones near the margins of pools left dry by the retiring tide. Some of the species inhabit mangrove swamps, and may be seen adhering to the roots above the surface of the water.

HINEA, Gray. Shell smooth, covered by a yellowish brown epidermis; whorls flattened, outer lip thick, sillonated within. *P. Braziliana*, Lam. (lxix, 45).

QUOYIA, Desh. (Fissilabra, Brown. Leucostoma, Swains.) Shell solid, elongated, whorls flattened, spirally striated, apex decollated; mouth small, slightly notched in front, sillonated within; columella smooth, truncate anteriorly, with a sharp spiral posterior callus. *P. decollata*, Quoy (lxix, 46).

HOLCOSTOMA, H. and A. Adams. Shell thin, aperture furnished with a posterior canal which extends up the last whorl; it is covered with an epidermis curiously adorned with rows of golden bristles. *P. piligerum*, Phil. (lxix, 47).

LITIOPA, Rang.

Etym.—*Litos*, simple; *ope*, aperture.

Distr.—10 sp. Pelagic. Atlantic and Mediterranean, on floating sea-weed, to which they adhere by threads. *L. bombyx*, Rang (lxix, 48). Fossil. Tertiary.

Shell minute, pointed; aperture slightly notched in front; outer lip simple, thin; inner lip reflected; operculum spiral.

The singular little oceanic mollusks which constitute this genus have the power of spinning glutinous threads by which they occasionally suspend themselves from the stems of floating sea-weed, among which they take up their abode; if the thread by any chance becomes divided, the animal emits a bubble enveloped in a glutinous secretion, which rises to the surface drawing out threads as it ascends, and finally becomes attached to the weeds above.

ALABA, H. and A. Ad., 1862.

Distr.—24 sp. Japan, Australia, Mazatlan, West Indies. *A. tervaricosa*, C. B. Ad.

Shell ovate, conical or elongated, subdiaphanous; whorls plicate or varicose, apex submammillate; aperture ovate, the columella more or less truncate.

DIALA, A. Ad., 1862. Whorls not varicose, sometimes noduled around the middle; columella straightish, not truncated; labrum not thickened. 5 sp. Philippines, Australia, Japan. *A. varia*, A. Ad.

STYLIFERINA, A. Ad., 1860. Diaphanous, conical-turreted; whorls smooth, convex; apex mucronate; aperture subquadrate; inner lip straight. 2 sp. Japan. *A. orthochila*, A. Ad.

FAMILY CERITHIIDÆ.

Shell spiral, elongated, many-whorled, frequently varicose; aperture channeled in front, with a less distinct posterior canal; lip generally expanded in the adult; operculum horny and spiral.

Animal with a short muzzle, typically not retractile; tentacles distant, slender; eyes on short pedicels, connate with the tentacles; mantle-margin with a rudimentary siphonal fold; tongue armed with a single series of median teeth, and three laterals or uncini. Marine, estuary, or fresh water.

CERITHIUM, Bruguiere.

Etym.—*Ceration*, a small horn.

Distr.—136 sp. Marine. World-wide, the typical species tropical. Norway, Britain, Mediterranean, West Indies, India, Australia, China, Pacific, Galapagos. Fossil, 460 sp. Trias—; Britain, France, United States, etc. *C. fusiforme* (lxix, 49).

Shell turreted, many-whorled, with indistinct varices; aperture small, with a tortuous canal in front; outer lip expanded; inner lip thickened; operculum horny, spiral.

Some of the species emit a bright green fluid when molested.

VERTAGUS, Klein. (Rhinoclavis, Swains. Lampanella, Mörch.) Canal strongly recurved, columella with an oblique median plication. *C. lineatus*, Lam. (lxix, 50).

CERITHIODERMA, Conrad. Acutely ovate, striate; labrum grooved and umbilicate; columella recurved inferiorly or subtruncate; aperture patulous, margin obtusely rounded inferiorly; beak very short, narrow, recurved. *C. prima*, Conr. (lxix, 51). Eocene; Alabama.

COLINA, H. and A. Adams. Shell elongated, whorls numerous, convex, nodulous, with revolving striæ; aperture oval, prolonged in front into a short, recurved canal; columella simple, oblique; outer lip expanded and reflexed. The middle whorls are gibbous,

and the sculpture usually becomes obsolete on the last whorl. The few species inhabit deep water, sandy bottom, at the Philippines, China, etc. *C. macrostoma*, Hinds (lxix, 52).

CERITHIELLA, Verrill, 1882. (Lovenella, Sars.) Shell subulate; whorls numerous, cancellated; aperture terminating in a short, distinct reflected canal. Norway, New England. *C. metula*, Lovén (lxix, 53).

BITTIUM, Leach. (Cerithiolum, Tiberi. Platygyra, Mörch.) Shell elevated, with numerous granular whorls, and irregular varices; anterior canal short, not recurved; inner lip simple; outer lip not reflected, usually with an exterior rib. Operculum four-whorled. Animal: Operculigerous lobe with rudimentary expansions on the sides and furnished with a roundish, lanceolate cirrus. Numerous small northern species, low-water to 80 fathoms. *C. reticulatum*, Da Costa (lxix, 54).

CERITHIOPSIS, Forbes and Hanley. Shell like Bittium; nuclear whorls sinistral. Operculum pointed, nucleus apical. Proboscis retractile. Northern. *C. rugulosus*, Ads. (lxix, 55).

SEILA, A. Ad. Shell like Cerithiopsis, transversely lirate.

CERITHINELLA, Gemm. Turreted to cylindrical, not perforated; mouth quadrangular, with very short canal; growth-lines recurved under the sutures. *C. Italica*, Gemm. Jurassic.

DITRETUS, Piette, 1874. Turreted; mouth oval or rounded, with very short, entirely rounded canal; inner lip spread out, callous; outer lip thickened; whorls with longitudinal rows of tubercles. *C. rostellaria*, Buv. Jurassic.

VICARIA, d'Arch, 1854. Turreted; whorls spirally striated, with a row of tubercles below the suture; canal short, recurved; inner lip callously thickened; outer lip with a deep, broad, superior sinus. *C. Verneuili*, d'Arch. Eocene; East Indies.

FIBULA, Piette, 1857. Shell elongated, columella straight, with a rudimentary groove near the base; outer lip arched, slightly notched at the suture; base of the aperture forming a slight canal, or rounded and entire, depending upon the exact period of growth at which the animal perished. The species of this genus possess characters intermediate and approximating them to Turritella and to Cerithium. Fossil, 21 sp. Jurassic to Cretaceous; Europe, India. *F. undulosa*, Piette (lxix, 56).

EUSTOMA, Piette, 1855. Shell in the young state resembling Cerithium; in the adult the margins of the aperture are much expanded and posteriorly united by an indistinct canal; canal elongated. Several species. Great Oolite; Ardennes.

CERITELLA, Morris and Lycett, 1850. (Costellifer, Meek. Tubifer, Piette.) Shell small, resembling Actæonina in form, the last volution being somewhat ventricose and largest, but terminating anteriorly with a short and slightly twisted canal. *C. acuta*, Morris and Lycett (lxix, 57). Jurassic.

MESOSTOMA, Deshayes, 1864.

Distr.—Fossil, 4 sp. Eocene; Paris. *M. grata*, Dh.

Shell elongated, turreted, scalariform; aperture nearly circular, dilated, obliquely cut, terminating in front by a semicanaliculated angle; columella slightly concave, cylindrical, obliquely truncated, lip simple, and slightly expanded.

EXELISSA, Piette, 1861.

Etym.—*Exelisso*, to unfold. *Syn.*—Kilvertia, Lycett, 1863.

Distr.—Fossil, 14 sp. Mid. Lias to Kimmeridge Clay; England and France. Cretaceous, 1 sp. (?); India. *E. formosa*, Lycett (lxix, 62).

Shell small, elongated subcylindrical, somewhat pupiform, many-whorled, perpendicularly costated, tuberculated or spined; last whorl cylindrical, contracted at the base, with a tendency to separate from the axis; aperture orbicular, entire, the lips elevated, produced, and slightly thickened; columella solid.

Includes a large number of very characteristic transversely ribbed species. It is uncertain whether there was an anterior canal or not, and therefore the pertinence of the genus to this family remains doubtful.

FASTIGIELLA, Reeve.

Distr.—1 recent sp.; and an Eocene sp., Paris basin. *F. carinata*, Reeve (lxx, 64).

Shell elongated, turriculated, whorls rounded, with revolving ribs; aperture prolonged into a short, slightly twisted canal; axis rimate.

TRIFORIS, Deshayes.

Syn.—Tristoma, Blainv.

Distr.—100 sp. E. Indies, Polynesia, Australia, Panama, W. Indies, Mediterranean. Fossil. Eocene; Europe. *T. perversus*, Linn. (lxix, 58).

Shell sinistral, sculptured, granular; whorls numerous, terminating below in a small aperture, with tubular anterior canal; opposite this canal is sometimes a second one upon a varix, marking the position of a former aperture. Operculum orbicular, few-whorled.

Animal. Tentacles clavate at the tips, united at their bases by a sinuated veil.

INO, Hinds. (Inella, Bayle.) Shell cylindrically subulate, elongated, spire sharp-pointed. *T. corrugatus*, Hinds (lxix, 59).

SYCHAR, Hinds. Shell elongated, whorls rounded. *T. vitreus*, Hinds (lxix, 60).

MASTONIA, Hinds. Shell acuminated, swollen in the middle. *T. vulpinus*, Hinds (lxix, 61).

LÆOCOCHLIS, Dunker and Metzger. Shell turreted; whorls

numerous, cingulated; aperture ending in a twisted, short canal. Operculum very thin, indistinctly spiral, with excentric nucleus. *T. granosus*, Wood (lxx, 65).

POTAMIDES, Brongniart.

Etym.—*Potamos*, a river, and *ides*, patronymic termination. Fresh-water Cerites. *Syn.*—Potomis, Swains.

Distr.—50 sp. Tropical and subtropical. Fresh and brackish, streams and swamps. Fossil, numerous. Eocene—. *P. mamillatum*, Risso (lxix, 63). *P. ebeninum*, Brug. (lxx, 66).

Shell turriculated, whorls angulated and coronated; aperture prolonged in front into a nearly straight canal; outer lip thin, sinuous; epidermis thick, olive-brown. Operculum many-whorled.

BROTIA, H. Adams. Shell fusiform, spire elevated, whorls spinulose, the last subrostrate in front; aperture subovate, produced anteriorly. Operculum corneous, multispiral. Fluviatile. Siam. *P. pagodula*, Gould (lxx, 67). The type was described as a Melanian, but the operculum at once separates it from that genus.

TYMPANOTOMUS, Klein. Columella twisted; outer lip broadly sinuated anteriorly, and less distinctly so posteriorly. *P. fuscata*, Linn. (lxx, 68).

LAMPANIA, Gray. Shell turriculated, whorls numerous, without varices; sculpture not prominent; aperture truncate below; without canal; outer lip sinuous. *P. zonale*, Brug. (lxx, 69).

PYRAZUS, Montfort. (Terebralia, Swains.) Whorls with revolving striæ, not tuberculate; aperture with a short anterior canal; columellar callosity spiral, oblique; outer lip thickened, expanded, rounded anteriorly, and turning upwards to join the inner lip. *P. sulcatum*, Brug. (lxx, 70). *P. palustris* occurs in great abundance in the salt marshes of the Eastern Archipelago, and is assiduously collected by the natives, who roast them and suck the contents of the shell through an aperture made by breaking off the tip of the spire.

Dr. Brot has made the interesting discovery that the species of this group possess two columellar plicæ, and opposite to these, upon the surface of the outer wall of the shell, are teeth, occurring wherever an external varix has been formed. These do not approach the aperture, and are only discovered upon making a longitudinal section of the shell. They do not occur in the related subgenera, but their presence is mentioned by Deshayes in some of the fossil species of the Paris basin, and they are very characteristic of the fossil genus Nerinæa, which may thus connect Cerithium and Pyramidella.

TELESCOPIUM, Montfort. (Terebralia, Swains.) Shell pyramidal; columella with a prominent fold, more or less continuous towards the apex; and a second, less distinct, on the basal front

of the whorls. India, North Australia. *P. telescopium* (lxx, 71) is so abundant near Calcutta as to be used for burning into lime; great heaps of it are first exposed to the sun, to kill the animals. They have been brought alive to England. (BENSON.) In Borneo they are eaten by the natives.

CERITHIDEA, Swains. Shell turriculated, longitudinally ribbed; whorls numerous; summit of spire more or less decollated, aperture rounded, slightly slit anteriorly, outer lip expanded, thickened, broadly rounded below and usually produced into a beak crossing the sinus to the left. Eye-pedicels long and thick, connate with the tentacles nearly to their tips. Inhabit salt marshes, mangrove swamps, and the mouth of rivers; they are so commonly out of the water as to have been taken for land-shells. Mr. Adams noticed them in the fresh waters of the interior of Borneo, creeping on pontederia and sedges; they often suspend themselves by glutinous threads *Distr.*—India, Ceylon, Singapore, Borneo, Philippines, Port Essington. *P. decollatum*, Linn. (lxx, 72). *P. obtusum*, Lam. (lxx, 73).

PIRENELLA, Gray, 1847. Shell turriculated, whorls granulated, or with irregular ribs and varices; aperture rounded; anterior canal short; inner lip simple, outer lip thin, sinuous. *P. mamillatum*, Phil. There is a fossil species in the Laramie beds, U. S.

SANDBERGERIA, Bosquet, 1861. Proposed for a number of ovate species, from the tertiary, having a very broad, shallow, but slightly produced canaliculation in front. The operculum is said to be paucispiral, and if this be actually the case, the division may be maintained, otherwise the shells are not readily distinguishable from Cerithidea. *P. antecedens*, Stol.

ESCOFFIERIA, Fontannes, 1881. *P. Fischeri*, Font. Tertiary; France.

FAMILY MELANIIDÆ.

Shell spiral, turreted; with a thick, dark epidermis; aperture often channeled, or notched in front; outer lip acute; operculum horny, spiral. The spire is often extensively eroded by the acidity of the water in which the animals live.

Animal with a broad, non-retractile muzzle; tentacles distant, subulate; eyes on short stalks, united to the outer sides of the tentacles; foot broad and short, angulated in front; mantle-margin fringed; tongue long and linear, with a median, and three lateral series of hooked multicuspid teeth; gill composed of rigid, cylindrical plates. Often viviparous. Inhabiting fresh-water lakes and rivers throughout the warmer parts of the world (except North America).

The Melanians are fluviatile mollusks, closely related through Potamides, with the Cerithiidæ. They possess the fringed mantle-margin characteristic of the latter family, and are thereby imme-

diately separable from the peculiarly North American group Strepomatidæ, which they much resemble in the characters of the shell. Mainly of Indo-Pacific, African and Polynesian distribution, they number several hundred existing species, besides a number of fossil forms commencing with the jurassic period.

PALUDOMUS, Swainson.

Etym.—*Palus*, a marsh, and *domus*, home.

Syn.—Rivulina, Lea.

Distr.—25 sp. Ceylon, India. *P. conicus*, Gray (lxx, 74).

Shell Paludiniform; columella callous, scarcely planulate. Operculum concentric, with spiral, sinistral, subcentral nucleus.

PHILOPOTAMIS, Layard. (Heteropoma, Benson.) Shell frequently globose, but spire exserted; columella callous, scarcely planulate. Operculum subspiral; nucleus basal, dextral, submarginal. *Distr.*—9 sp. Ceylon, Sumatra. *P. nigricans*, Reeve (lxx, 75).

TANALIA, Gray. (Ganga, Layard. Serenia, Benson.) Shell globose, neritiform; columella wide, planulate. Operculum lamellated, nucleus dextral, median, marginal. *Distr.*—7 sp. Ceylon. *P. loricata*, Reeve (lxx, 76).

STOMATODON, Benson. Shell globose, columella wide, base truncate and furnished with a prominent tooth. Operculum (?). *Distr.*—*P. Bensoni*, Brot. (lxx, 77). Southern India.

MELANIA, Lam.

Etym—*Melania*, blackness (from *melas*).

Distr.—400 sp. So. Europe, India, Philippines, Pacific Islands.

Shell turreted, apex acute (unless eroded); whorls ornamented with striæ or spines; aperture oval, pointed above; outer lip sharp, sinuous. Operculum subspiral.

MELANELLA, Swainson. Shell ovoid, with elevated spire; aperture large, its base subproduced and rounded. Operculum paucispiral, nucleus subspiral. *M. glans*, von dem Busch (lxx, 78). Java. Includes *M. Hollandri*, Fer., and *M. parvula*, Schmidt; European species.

ACROSTOMA, Brot. Shell fusiform, subbiconic; aperture angulately produced at the base. Operculum (?). *M. Hügelii*, Phil. Java, India.

PACHYCHILUS, Lea. Shell turreted or subfusiform; aperture ovate, its base subproduced, peristome usually thickened. Operculum three- to four-whorled, with subcentral nucleus. Mexican, Central American. *M. lævissima*, Sowb. (lxx, 79).

AYLACOSTOMA, Spix. (Aulacostoma, Agassiz.) Whorls carinated or shouldered near the suture. South America. *M. scalaris*, Spix (lxx, 80).

SULCOSPIRA, Troschel. Shell ovately turreted, sulcate-striate;

aperture ovate, base subproduced. Operculum three- to four-whorled, nucleus subcentral, rarely subbasal. *M. sulcospira*, Mousson (lxx, 81). East Indies.

NIGRITELLA, Brot. Shell ovoid-turreted, smooth, but slightly granosely striate. Operculum subspiral, nucleus submarginal. *M. decollata*, Lam. (lxx, 82). Africa, Madagascar.

MELANOIDES, Olivier. Shell turreted, usually large, elevately striate and plicate, plicæ usually tuberculose. Operculum subtrispiral, nucleus excentric, sinistral. East Indies, Philippines. *M. asperata*. *M. variabilis*. *M. episcopalis*, Lea (lxx, 83).

MELANIA, H. and A. Adams. (Ellipstoma, Raf.) Shell usually subulate, whorls numerous. Operculum paucispiral, nucleus submarginal. *M. hastula* (lxx, 84). *M. Mindoroensis*. *M. acuminata*. East Indies, Polynesia.

STRIATELLA, Brot. Turreted, spirally more or less striate, sometimes longitudinally plicate, aperture rounded at the base, columella a little twisted. *M. corporosa*. *M. tuberculata* (lxx, 85). Java, Polynesia.

PLOTIA (Bolten), H. and A. Adams. Shell medium or small, spirally closely striate or lirate; whorls angulate and spiny above; corneous, strigate or punctate with red. Operculum subspiral, nucleus submarginal, basal. *M. spinulosa*. *M. bellicosa*, Hinds (lxx, 86).

PLOTIOPSIS, Brot. Shell like the preceding, but shortly tuberculose (not spinose) at the angle. Operculum subspiral, nucleus submarginal. *M. Balonnensis*, Conr. (lxx, 87).

TIARA (Bolten), H. and A. Adams. (Amarula, Sowb. Melas, Montf. Melacantha, Swainson. Paramelania, E. A. Smith.) Shell usually large, mostly smooth, rarely with elevated cingulæ, whorls angulated and spinose above. Operculum paucispiral, nucleus submarginal. *M. amarula*. *M. setosa*, Swains. (lxx, 88).

TIAROPSIS, Brot. Shell medium size, lirate or sulcate; whorls with a single row of nodules or short spines above; margin of the aperture sinuous. *M. Winteri*, Busch (lxx, 89).

TAREBIA, H. and A. Adams. Shell oblong or ovately turreted, granosely decussated; aperture-margin sinuous. Operculum paucispiral, nucleus submarginal. *M. Celebensis*, Quoy (lxx, 90).

SERMYLA, H. and A. Adams. Shell Tornatelliform, above longitudinally costate, below with revolving liræ; aperture-margin sinuous. Operculum paucispiral, nucleus submarginal. *M. tornatella*, Lea (lxx, 91).

ONCOMELANIA, Gredler. Shell rimate, turreted, strongly ribbed, ribs pellucid; aperture scarcely effuse below, small; peristome continuous or connected by a columellar callus, widely sublabiate, with an exterior varix. 1 sp. China. The operculum is of the normal form. The position of this shell is

somewhat doubtful; it may belong to the Rissoidæ. *M. Hupensis*, Gredler (lxx, 92).

PTYCHOSTYLUS, Sandberger.

Distr.—*P. harpæformis*, Dunker. Wealden, Europe,

Shell egg-shaped, with scalariform, sharp spire; whorls ribbed transversely; mouth small, acutely angular behind, somewhat wider and rounded in front; columella folded.

DORYSSA, H. and A. Adams.

Distr.—17 sp. Eastern South America. *D. brevior*, Troschel (lxxv, 93).

Shell turreted, longitudinally plicate, decussated by revolving sulcations; aperture effused at the base, right margin uncinately produced. Operculum spiral with sinistral subcentral nucleus (?).

CLAVIGER, Haldeman.

Syn.—Vibex (Oken), Gray.

Distr.—7 sp. Africa. *C. aurita*, Lam. (lxxi, 94).

Shell turreted, with revolving carinæ or tubercles; aperture subproduced at the base, subcanaliculate, outer margin sinuous, two to four plicæ within. Operculum paucispiral; nucleus basal, submarginal, sinistral.

TIPHOBIA, E. A. Smith.

Distr.—Lake Tanganyika, Africa. *F. Horei*, Smith (lxxi, 95).

Shell subturbinate, spire depressed; whorls flattened above, angulated and spinose; axis and aperture prolonged into a channeled beak.

Similar in form to the American genus Io. The operculum is unknown. It has been referred temporarily to the family Melaniidæ, but is quite as closely allied, I think, to the fresh-water division of the Cerithiidæ, and especially to the Siamese genus Brotia.

HEMISINUS, Swainson.

Syn.—Basistoma, Lea. Tania, Gray.

Distr.—36 sp. So. and Central America, W. Indies, Seychelles, Australia. *H. lineolatus*, Wood (lxxi, 96).

Aperture canaliculated at the base, columella not callous. Operculum paucispiral; nucleus basal, sinistral, marginal or submarginal.

VERENA, H. and A. Adams. Shell turbinated, shouldered and coronated, spirally striate; aperture subtruncated anteriorly, forming a short, wide canal. South America. *H. crenocarina*, Moric. (lxxi, 97).

MELANOPSIS, Ferussac.

Syn.—Bulliopsis, Conrad. Coptostylus and Campylostylus, Sandb.

Distr.—41 sp. Mediterranean region of Europe, Asia and Africa, New Caledonia, New Zealand. Fossil, 25 sp. Eocene—; Europe, United States. *M. prærosa*, Linn. (lxxi, 99).

Aperture excised-canaliculate at the base, a thick, tubercular parietal callus above. Operculum subspiral or paucispiral, nucleus sinistral, marginal or submarginal.

CANTHIDOMUS, Swainson. Spire generally short; whorls coronated or longitudinally ribbed, last whorl anteriorly obtuse. *M. costata*, Fer. (lxxi, 98).

LYRCEA, H. and A. Adams. Shell oval-fusiform, whorls grooved; inner lip with a large posterior callus; columella subtruncate in front; aperture posteriorly canaliculated. *M. Dufourii*, Graells.

MELANOPTYCHA, Neumayr, 1880. Columella plicate. Tertiary; Austria. *M. Bittneri*, Neumayr (lxxi, 100).

SMENDOVIA, Tournouër, 1882.

Distr.—*S. Thomasi*, Tourn. Tertiary; Algiers.

Shell large, fragile, fusiform; spire acute; last whorl gibbous, longitudinally plicate; columella callous (callus tumid, not produced behind), almost straight, anteriorly somewhat produced into a recurved canal, which is scarcely margined.

STOMATOPSIS, Stache.

Distr.—*S. crassicostata*, Stache. Cosinaschichten, Dalmatia.

Shell thick, long ovate, spire sharp, scalariform, with sharp, fold-like transverse ribs, affecting the sutural line; mouth rounded or oval, somewhat angular, with thickened lip.

FAUNUS, Montfort.

Syn.—Pirena, Lam. Faunopsis, Gill (young shell).

Distr.—4 sp. Ceylon, Philippines, Western Polynesia. *F. atra*, Linn. (lxxi, 1).

Shell subulate, smooth; aperture profoundly excised-emarginate at the base, sinuate above; columellar lip callous. Operculum (?).

The species of this genus, which differs from Melanopsis in the length of the spire, and in the sinuated, broadly-expanded outer lip, inhabit the beds of tropical rivers and rivulets, where they may be seen crawling on the soft mud at the bottom, feeding, apparently, on decayed vegetable matter.

MELANATRIA, Bowd.

Distr.—5 sp. Madagascar. *M. fluminea*, Gmel. (lxxi, 2).

Shell turreted, smooth or costate, sometimes spinose; aperture more or less sinuous at the base and above. Operculum spiral; nucleus sinistral, subcentral.

PIRENOPSIS, Brot. Solid, turreted, longitudinally ribbed, spirally

striate, not spinose; aperture sinuate above and below, outer margin widely arcuately protracted. Operculum acutely ovate, subspiral, nucleus basal, submarginal. *M. costata*, Quoy.

FAMILY STREPOMATIDÆ.

Shell turreted, or ovate, smooth or variously sculptured, covered with an olivaceous epidermis; aperture angulated or channeled in front. Operculum subspiral.

Animal with plain (not fringed) mantle-margin. Oviparous. Dentition (xl, 27).

Except two or three West Indian species, the distribution of the family, numbering about 500 species, is confined to the United States, and principally to the upper waters of the streams taking their rise in the mountains of the middle southern region.

The oriental Melaniidæ have fringed mantle-margins, and the shells have generally a broadly rounded aperture, not produced at the base.

Io, Lea.

Syn.—Melafusus, Swains.

Distr.—5 sp. Middle and East Tennessee, W. Virginia. *I. spinosa*, Lea (lxxi, 3, 4).

Shell fusiform, usually nodulous, with elevated spire; aperture produced anteriorly into a narrow, twisted canal; columella smooth, concave.

ANGITREMA, Haldeman.

Syn.—Potadoma (part) Swains. Glotella, Gray. Juga (sp.), Chenu. Meseschiza, Lea.

Distr—12 sp. Indiana, Tennessee, Northern Alabama. *A. Duttoniana*, Lea (lxxi, 5).

Shell spinous; aperture subrhomboidal, with an anterior short canal; columella with a callous deposit anteriorly and posteriorly. Meseschiza is founded upon young specimens of *A. armigera*, Say, in which the growth of the outer lip has been interfered with at its periphery, causing a seam and slight sinus; it is undoubtedly monstrous.

LITHASIA, Haldeman. (Megara [sp.], H. and A. Adams.) Shell ovately fusiform or oval, small, smooth; aperture not so distinctly channeled in front as in the typical Angitremæ; columella with anterior and posterior callous deposit. 14 sp. Ohio River, Indiana, Kentucky, Tennessee, Alabama. *A. dilatata*, Lea (lxxi, 6).

STREPHOBASIS, Lea. (Megara [sp.], H. and A. Adams.) Shell like Lithasia, with retrorse canal. 9 sp. Tennessee, Alabama. *A. curta*, Hald. (lxxi, 7).

PLEUROCERA, Rafinesque. (Ceriphasia, Swainson. Telescopella, Gray. Trypanostoma, Lea. Megara and Elimia [sp.], H. and A.

Adams. Strepoma, Raf.) Shell generally lengthened conical, with elevated spire; aperture moderate, produced into a short spout or canal in front; columella not callously thickened. *Distr.*—84 sp. Ohio, Tennessee and Alabama Rivers and their tributaries. *P. canaliculata*, Say (lxxi, 8).

GONIOBASIS, Lea.

Syn.—Melasma, Juga, Megara (sp.), Elimia, H. and A. Adams.

Distr.—274 sp. United States, east of the Mississippi River, California and Oregon. *G. impressa*, Lea (lxxi, 9). *G. Boykiniana*, Lea (lxxi, 10). *G. Virginica*, Say (lxxi, 11). The genus does not occur recent in the elevated region west of the Mississippi. Fossil, Laramie beds—; Western U. S.

Shell heavy, ovate or elongated; aperture somewhat angulated in front, but neither notched or canaliculate.

EURYCÆLON, Lea. Shell obovate, heavy, nodosely angled; aperture large, ear-shaped; columella oval, subtruncate. 10 sp. E. Tennessee, N. Alabama. *G. Anthonyi*, Budd (lxxi, 12).

PYRGULIFERA, Meek.

Distr.—Cretaceous; Wyoming T., U. S. *P. humerosa*, Meek (lxxi, 13).

Spire produced; whorls shouldered and nodular; aperture subovate, faintly sinuous, a little produced, but not notched or distinctly angular below; columellar lip a little callous below, thickened throughout. Very closely allied to the Melanian genus Tiara, Bolten. Dr. C. A. White considers Paramelania, E. A. Smith (= Tiara), synonymous; it includes three species living in the African lake Tanganyika.

CASSIOPELLA, White, 1878.

Distr.—*C. turricula*, White. Fossil, Laramie beds; Western U. S.

Shell turriculate, the whorls angulated in the middle. Differs from Goniobasis in being umbilicated.

SCHIZOSTOMA, Lea.

Syn.—Schizocheilus, Lea. Gyrotoma, Shuttleworth. Melatoma, Anthony. Apella, Mighels.

Distr.—26 sp. Coosa River, Alabama. *S. babylonicum*, Lea (lxxi, 14–16).

Shell conical or fusiform; aperture large, ovate, obtusely angled below; outer lip with a posterior, sutural sinus or fissure; columella smooth, incurved.

ANCULOSA, Say.

Syn.—Anculotus, Say. Ancylotus, Herm. Leptoxis (Raf?), Hald.

Distr.—26 sp. Ohio River and southwards to Alabama; Southern Atlantic States. *A. tæniata*, Conr. (lxxi, 17).

Shell oval, heavy, with very short spire; aperture entire and rounded in front; columella callously thickened above.

MUDALIA, Hald. (Nitocris, H. and A. Ad.) Shell thinner, inflated. Potomac and Susquehanna, Kanawha, and Upper Ohio rivers. The distribution is thus more northern than that of the type group. *A. dissimilis*, Say (lxxi, 19).

FAMILY RISSOELLIDÆ.

Shell small, thin, transparent, spire elevated, aperture entire, rounded or slightly sinuous anteriorly. Operculum corneous, concentric.

Animal with bilobate rostrum, eyes sessile on the head back of the tentacles.

These curious little animals are found adhering to floating seaweeds, in pools between tide-marks; their eyes are situated so far behind the tentacles that the transparency of the shell seems to be essential to the vision of the animal. The bilobate mouth and absence of retractile proboscis indicate them to be vegetable feeders. In some respects closely allied to Litiopa.

RISSOELLA, Gray.

Syn.—Jeffreysia, Alder.

Distr.—6 sp. Britain. On sea-weed, near low-water. (ALDER.) There are eight other species in the Japanese seas. *R. diaphana*, Forbes and Hanley (lxxi, 20, 21).

Shell minute, translucent. Operculum semilunar, imbricated, with a projection from the straight, inner side. Head elongated, deeply cleft, and produced into two tentacular processes; mouth armed with denticulated jaws, and a spinous tongue; tentacles linear, eyes far behind, prominent, only visible through the shell; foot bilobed in front.

FAIRBANKIA, Blanford, 1868.

Distr.—*F. Bombayana*, Blf. Estuary; Bombay Harbor.

Shell imperforate, turreted, with a brown epidermis; aperture suboval, rounded in front; peristome slightly dilated, external margin acute, but exteriorly with variciform thickening. Operculum corneous, subannular with an interior long, transverse rib.

Animal with long filiform tentacles, and eyes sessile at their bases; proboscis elongated; foot wide and sinuated in front, rounded behind.

Combines the epidermis, and to a great extent the animal of Hydrobia with the peristome of Rissoa; the operculum approaches that of Rissoella. It differs from Barleeia in its

epidermis, exteriorly thickened lip, horny operculum, and want of long pointed apophysis.

IRAVADIA, Blanford, 1867.

Distr.—*S. ornata*, Blf. Brackish water, India.

The shell has the general form of a Rissoa, but the apex is often obtuse, the whorls are spirally ribbed, covered with an epidermis; aperture ovate, with continuous margins, anteriorly slightly effuse; outer lip with an external varix. Operculum and animal unknown.

HYALA, H. and A. Adams.

Distr.—European. *H. vitrea*, Forbes and Hanley (lxxi, 22).

Shell thin, hyaline, elevated conic; aperture oval, slightly emarginated anteriorly; outer lip thin, simple. Operculum thin, corneous, simple, subspiral. The tentacles of the animal have bristle-like summits.

TATEA, Woods.

Distr.—Tasmania. *T. Huonensis*, Woods (lxxii, 30).

Shell elongate-pyramidal. Operculum calcareous, with a vertical, submarginal claw. Animal with truncate foot, and long tentacles.

The operculum has the form of that of Rissoella, but differs in being calcareous.

FAMILY RISSOIDÆ.

Shell small, spiral, turreted or depressed, often more or less umbilicated; aperture more or less rounded, never truly channeled in front; peritreme continuous.

Tentacles elongated, with the eyes at their outer bases. Verge (male organ) exserted, situated on the back at a considerable distance behind the right tentacle. Gills both pallial; the right or principal one usually rather short and broad, and composed of few laminæ, which are much broader than high. Foot oblong, punctate before, rounded or pointed behind. Operculigerous lobe well developed. Operculum horny or partly shelly, spiral or concentric. Lingual teeth, 3·1·3; living in fresh, brackish or sea-water, sometimes amphibious. Distribution mundane.

Stoliczka indicates two principal groups in this family: the first including the marine genera, with thick, solid shells, and, as a rule, with the labrum externally thickened; the other the brackish and fresh-water or amphibious genera, the shells of which are usually thin, smooth, with an olivaceous epidermis, the labrum not externally thickened. The animals of all the Rissoidæ are very similarly formed, but those living in fresh or brackish waters have generally no appendages on the posterior portion of the foot, and the operculigerous lobes are less developed than in the marine forms. The eye-peduncles are generally

united with the tentacles, but it seems that their length increases, the more the animal is accustomed to an amphibious life. Thus some of the species have the eyes placed near the basis of the tentacles, others in the middle, and still others at the tips of the same. The differences are very gradual, which makes it impossible to regard them as of any important generic value. The length of the rostrum also appears to increase in some forms, corresponding with their more amphibious habits; and also, while the foot itself often lengthens, its disk at the same time becomes smaller.

SUBFAMILY *BYTHININÆ*.

Shell small, conical; peritreme simple or thickened. Operculum calcareous, concentric. Fresh water.

BYTHINIA, Gray.

Syn.—Elona, Moquin-Tandon. Grayana, Betta.

Distr.—50 sp. Europe, Southern Asia, Australia, etc. Fossil. Wealden and Tertiary. *B. Leachii*, Shepp. (lxxii, 29).

Shell oval, turbinated, thin, invested with a thin epidermis; peritreme continuous.

The female is oviparous and deposits her eggs in a band, attached to stones or the stems of aquatic plants; with her mouth she clears the surface upon which she intends to deposit the ova. The young are hatched in three or four weeks, attaining full growth in the second year.

TYLOPOMA, Brusina, 1882. Shell form of Tulotoma (Paludinidæ), but smaller. Operculum calcareous. *B. avellana*, Neum.

GABBIA, Tryon. Shell turbinately globose, whorls well rounded; peritreme continuous; axis perforate. Operculum, nucleus subspiral, afterwards concentric, calcareous. *Distr.*—*B. australis*, Tryon (lxxi, 23). Fresh water, Australia. It is possibly synonymous with Bythinia, from which it only differs slightly in its operculum.

STENOTHYRA, Benson.

Syn.—Nematura, Benson.

Distr.—Fresh water, India, East Indies. Fossil. Eocene; Paris basin. *S. deltæ*, Benson (lxxii, 31).

Shell ovate, smooth, imperforate; aperture rounded, contracted. Operculum testaceous, annular, ovate, thick, nucleus subcentral, margin grooved.

The species are found either attached to the under surface of floating leaves, or crawling out of the water on the muddy margins of ponds, leaving, as they progress, slender tracks behind them.

NEMATURELLA, Sandberger. Like Stenothyra, but with longer spire; lip flexuous, forming a slight sinus above. Operculum unknown. Pliocene; Europe. 4 sp.

EUCHILUS, Sandberger. Shell small, elongate-conoidal, smooth, rimate; outer lip expanded. Operculum concentric, calcareous. Tertiary; Europe. 9 sp. *E. Deschiensianum*, Sandb. (lxxiii, 4).

SUBFAMILY *SKENEINÆ.*

Shell depressed, nearly discoidal. Operculum multispiral, corneous. Marine.

SKENEA, Fleming.

Etym.—Named after Dr. Skene, of Aberdeen, a contemporary of Linnæus.

Syn.—Delphinoïdea, Brown.

Distr.—Northern seas, Norway, and Britain. *S. cornuella*, Straits of Korea (Adams). *S. planorbis*, Fabr. (lxxii, 32, 33).

Shell minute orbicular, depressed, few-whorled; peristome continuous, entire, round. Operculum multispiral. Animal like Rissoa, foot rounded behind. Found under stones at low-water, and amongst the roots of *Corallina officinalis.*

SUBFAMILY *RISSOININÆ.*

Shell ovate or turreted; with a thick, corneous, or calcareous paucispiral operculum provided with an internal process (articulated). Size small. Marine.

The genera are well characterized, not only by the form of the operculum, but especially by the form of their aperture, which is anteriorly effuse or truncate; the outer lip being peculiarly produced either anteriorly or near the middle.

RISSOINA, d'Orbigny.

Distr.—About 100 sp. World-wide. *R. Catesbyana*, d'Orb. (lxxi, 24, 25).

Shell turreted, whorls numerous, ribbed or cancellated; aperture semilunar, lip slightly thickened within, somewhat expanded, faintly channeled anteriorly. Operculum corneous, thick, semilunar, paucispiral, with an interior process.

ISSELIELLA, Nevill. (Isselia, Semper, preoccupied.) The embryonal shell is sinistral, and von Martens thinks that it should therefore be removed to the neighborhood of Cerithiopsis. The shells do not otherwise differ essentially from Rissoa, and I agree with Dr. Weinkauff that, while the animal and operculum remain unknown, it is better to allow the species to remain in Rissoina. *R. mirabilis*, Dunker, is the type, and there are several other Polynesian species.

ZEBINA, H. and A. Adams. Shell white, solid, opaque, polished, smooth or partly striate; outer lip rather thick, with one or more internal anterior tubercles. *R. tridentata* (lxxi, 26).

ZEBINELLA, Mörch. Shell costellate, spirally striate. *R. elegantissima*, d'Orb. (lxxi, 27).

PHOSINELLA, Mörch. Shell reticulated, aperture profoundly sinuated. Operculum with styliform apophysis, denticulate posteriorly. *R. Sagraiana*, d'Orb. (lxxii, 37).

SCHWARTZIELLA, Nevill. Aperture without basal emargination. *R. coronata* (lxxii, 34).

EATONIELLA, Dall. (Eatonia, E. A. Smith.) Shell rissoid, smooth; aperture subcircular, peristome simple, continuous, the labral margin not thickened. Operculum paucispiral, nucleus near the base, with an interior rib or ossicle. Differs from Rissoina in the absence of the basal, faint channel of the aperture and thin lip. *Distr.*—3 sp. Kerguelen's Island. *R. Kerguelenensis*, Smith (lxxii, 35, 36).

MICROSTELMA, A. Ad., 1863. Shell turreted-ovate, rimate; spire conic; whorls longitudinally plicate; aperture oblong, produced anteriorly, subcanaliculate; inner lip thickened, outer lip simple. *Distr.*—*R. dædala*, A. Ad. Japan.

BARLEEIA, Clark.

Etym.—Named in honor of G. Barlee.

Distr.—Europe, W. America, etc. *B. rubra*, Ads. (lxxii, 38).

Shell conically turbinated; whorls rounded, smooth or slightly striated; aperture oval, entire, rounded in front; margin sharp. Operculum calcareous, subangular, with an internal rib-like process.

Operculigerous lobe simple; foot slightly emarginate posteriorly. The tentacles in this genus are short, broad, rounded at the tips and not setaceous; the eyes are large, on inflations at the outer bases of the tentacles; the rostrum is simple and not cloven; the foot is emarginate behind, and the operculum lobe is simple. The operculum is subannular as in Rissoella, and is furnished with a similar internal appendage; Rissoina has a similar appendage, but the operculum in that genus is paucispiral.

BACULA, H. and Adams, 1863.

Distr.—*B. striolata*, H. and A. Adams. China Sea.

Shell resembling Eulima, but without enamel; whorls spirally striated, inner lip thickened, as in the next genus, outer lip without a varix, produced either in the middle or somewhat anteriorly. The classification of Bacula in this place is only provisional.

KEILOSTOMA, Desh., 1848.

Syn.—Paryphostoma, Bayan., 1873.

Distr.—7 Cret. and 6 Eocene sp. Europe, India. *K. eximia*, Desh. (lxxii, 39).

Elongate, turriculated, frequently nearly smooth, aperture ovate, oblique, entire, narrow, subcanaliculate behind, truncate, subeffuse anteriorly, smooth within; both lips thickened, the

outer one laterally produced, the inner wide, callous; columella solid.

SUBFAMILY *RISSOINÆ.*

Shell ovate or elongated. Operculum paucispiral, not provided with a process. Foot of animal without lateral processes. Size small. Marine.

RISSOA, Frémenville.

Named after the French zoologist, Risso.

Syn.—Rissostomia, Sars.

Distr.—About 75 sp. Universally distributed, but most abundant in the north temperate zone. *R. costulata*, Risso (lxxi, 28).

Shell minute, white or horny; conical, pointed, many-whorled; smooth, ribbed, or cancellated; aperture rounded; peristome entire, continuous; outer lip slightly expanded and thickened; operculum subspiral.

The animal has long, slender tentacles, with eyes on small prominences near their outer bases; the foot is pointed behind; the operculigerous lobe has a wing-like process and a filament (cirrus) on each side. Lingual teeth single, subquadrate, hooked, dentated; uncini 3; 1 dentated, 2, 3, claw-shaped. They range from high-water to 100 fathoms, but abound most in shallow water, near shore, on beds of fucus and zostera.

Rissoa is active and bold, floats like its congeners, and spins a byssal thread instantaneously on being detached from a crawling position. The incessant play of the cilia that fringe the tentacles is very striking; it appears to be caused by the action of a double row of muscles in each tentacle, arranged in the form of a siphon, which is perceptible through the transparency of the integument. The pallial filaments probably serve the purpose of supplementary tentacles to warn the animal of impending danger.

MANZONIA, Brusina. Peristome duplicate. There are 8 European species.

ANABATHRON, Frauenfeld. Shell very small, thick, oblong, angulate, scalariform, imperforate, smooth; aperture rounded, peritreme continuous. Operculum corneous. Australia. *R. contabulata*, Frauenf. (lxxii, 40).

PLAGIOSTYLA, Fischer. Shell transparent, apex papillary, last whorl descending, aperture semilunar, pillar-lip oblique, rectilinear. Europe.

ZIPPORA, Leach. (Acme, H. and A. Adams.) Shell subcylindrical, smooth or longitudinally ribbed; margin of aperture reflected. *R. Moutonii*, Dupuy (lxxii, 41).

PTEROSTOMA, Deshayes, 1864. Shell elongated, turriculated; peristome continuous, circular, very dilated and margined; colu-

mella very broad, expanded, and continuous with the peristome. *P. tuba*, Desh. (lxxii, 42). Eocene; Grignon, Paris.

SETIA, H. and A. Adams. Shell thin, oval-oblong or subconic; whorls few, ventricose, spotted; spire short, apex obtuse; aperture suborbicular. Animal with pilose tentacles. *R. pulcherrima*, Jeffreys (lxxii, 43).

CERATIA, H. and A. Adams. Shell subcylindrical, spirally striated, white, thin, subpellucid; whorls rounded, summit of spire obtuse; aperture suboval; peristome continuous, the outer lip thin and sharp. Animal with flattened, mostly short and claviform tentacles; foot bifurcate behind. *R. proxima*, Alder (lxxii, 44).

CINGULA, Fleming. Shell thin, elongated, smooth or spirally striate, spotted or banded; aperture pyriform or oval; outer lip sharp, with an external varix. *R. cingillus*, Montf. (lxxii, 45).

ONOBA, H. and A. Adams. Shell elongated; whorls numerous, rounded, spirally striate; aperture oval; peristome continuous, thick, simple or slightly reflected. *R. striata*, Mont. (lxxii, 46).

ALVANIA, Risso. Shell oval, turbiniform; spire short, apex sharp; whorls rounded, usually cancellated; aperture subcircular, crenulated within; outer lip with a marginal exterior varix. *R. abyssicola*, Forbes (lxxii, 47).

SABANÆA (Leach), Frauenfeld. Shell thick, stout, smooth. Australia, Europe. *R. flammea*, Frauenf. (lxxii, 48).

CORENA, A. Ad. Shell elately turbinate, rimate, apex obtuse; aperture circular, with continuous peritreme; inner lip with a thin callous expansion, and acute posterior tubercle; outer lip with duplicated margin, well-reflected. *Distr.*—1 sp. Gulf of Suez.

HEMISTOMIA, Crosse. Shell subimperforated, elongated, thin; spire long, summit obtuse, suture well-marked; aperture obliquely semilunar; peristome simple, continuous, almost detached; columellar margin very oblique, thickened; basal margin widely rounded. Operculum unknown. New Caledonia. *R. Caledonica*, Crosse (lxxii, 49).

AMPHITHALAMUS, Carpenter, 1865. Shell rissoid, with a large nucleus; inner lip produced, outer lip joining it subposteriorly, suddenly contracted in the adult. Several minute species. California, Japan. *R. inclusa*, Carp.

FENELLA, A. Ad., 1860. Has the pupoid form of Rissoa, with longitudinal and transverse ribs; the outer lip without a varix. May perhaps belong to Pyramidellidæ, with which the animal nearly corresponds. *R. pupoides*, A. Ad. Japan.

DIASTOMA, Desh., 1848. Shell turreted, whorls with numerous transverse ribs, and with a few intermediate varices. Inner margin of the aperture partially detached from the previous whorl; the aperture itself is strongly contracted posteriorly.

As yet only known fossil in tertiary deposits. *R. variculosa*, Desh. (lxxii, 50).

NEVILLIA, H. Adams.

Dedicated to Mr. Geoffrey Nevill, an Anglo-Indian conchologist.

Distr.—2 sp. Mauritius, Isle of Bourbon. *N. picta*, H. Adams (lxxi, 52).

Shell imperforate, acutely ovate; whorls convex, spirally lirate, longitudinally striate; aperture oval; columella callous, toothed; lip acute, smooth within, varicose outside.

This genus has much the appearance of a minute species of Craspedotus, but there is no indication of nacre within the aperture, and the tooth on the columella is more like that of *Rissoa monodonta;* in form and sculpture Nevillia approaches Alvania.

PUTILLA, A. Ad., 1867.

Distr.—*P. lucida*, A. Ad. (lxxii, 51). Japan.

Shell turbinately conoidal, solid, smooth, rimate; aperture suborbicular; lip thickened, subeffuse in front, scarcely expanded. Family relationship obscure.

SUBFAMILY *HYDROBIINÆ*.

Shell very small, or of moderate size, never exceeding two-fifths of an inch in length, globose, ovate, or elongated, generally umbilicated or rimate, and covered with a periostraca for the most part of an olive-color; whorls moderately numerous (4–8), smooth, or, rarely, ribbed or carinated, never cancellated; aperture more or less ovate or rounded, rarely subacute or effuse anteriorly; peritreme continuous; outer lip usually simple and acute. Operculum paucispiral, corneous. Tentacles, verge and gills as in the diagnosis of the family (p. 259). Foot without lateral sinuses, truncate and auricled in front, and generally rounded behind; operculigerous lobe destitute of cirri. Station, in fresh and brackish water.

Like all of the Rissoidæ these little animals are strictly herbivorous. Moquin-Tandon remarks that they have, connected with the stomach, a cartilaginous stylet like that occurring in certain bivalves. Something like this stylet Stimpson has observed also in our American Melanians.

LITTORINELLA, Braun.

Syn.—Paludinella, Lovén (not Pfeiffer). Littorinidea, Eyd. and Soul.

Distr.—World-wide, brackish or sea-water, in sheltered positions. *L. minuta*, Totten (lxxii, 53).

Shell ovate or elongated, thin, smooth, perforate; whorls ventricose; apex obtuse; aperture rather broadly oval; inner lip not thickened. Operculum corneous.

In *L. minuta* the rostrum is rather long, the tentacles very slightly tapering, blunt at the end, foot rounded behind.

HYDROBIA, Hartmann.

Syn.—Paludinella, Lovén. Peringia, Paladilhe.

Distr.—World-wide, brackish water. *H. ulvæ*, Pennant (lxxii, 54).

Shell ovate or elongated, smooth, subperforate; spire conic; whorls flat; apex acute; aperture ovate; inner lip not thickened. Operculum corneous.

Rostrum rather long, tentacles somewhat tapering, but blunt at the extremity. Foot somewhat pointed behind.

EMMERICIA, Brusina.

Distr.—Living, 2 sp. Adriatic Region. *E. patula*, Brum.

Shell small, conoidal, rimate, smooth, shining, spire elevated; aperture patulous; peristome subcontinuous, inner lip adnate, the outer lip sinuate, wide, reflected. Operculum corneous, ovate, paucispiral, nucleus excentric.

TOURNOUERIA, Brusina. Peristome inferiorly evased, simple. 1 recent, several tertiary species. Europe.

STALIOLA, Brusina, 1870. Peristome with a strong exterior marginal rib. Tertiary; Europe. 1 recent sp.

NYSTIA, Tournouer, 1869. (Forbesia, Nyst.) Aperture oblique, exteriorly swollen, spire truncate. Tertiary; Europe. *E. microstoma*, Desh.

BITHYNELLA, Moquin-Tandon.

Syn.—Leachia, Risso. Subulina, Troschel. Paludinella, Frauenfeld. Microna, Ziegler. Thermhydrobia, Paulucci. Frauenfeldia, Clessin.

Distr.—Fresh water, Europe, America, including California. *B. viridis*, Moquin-Tandon (lxxii, 55, 56).

Shell elongated-ovate, usually somewhat pupiform, imperforate, or simply rimate; apex obtuse; aperture oval or rounded; peritreme continuous, outer lip slightly thickened. Operculum corneous, nucleus moderately large, not very close to the basal margin.

Tentacles tapering, blunt at the tip; foot rather narrow, rounded behind; verge bifid.

STIMPSONIA, Clessin. Proposed for the North American species, which differ from the European type in dentition.

VITRELLA, Clessin. (Bythiospeum, Bourg., 1882.) Shell small, thin, without sculpture; peritreme continuous, sharp. Operculum paucispiral. Animal blind. Inhabits caves and streams in Europe. 15 sp. *B. pellucida*, Clessin (lxxii, 57).

MOITESSIERIA, Bourg. Shell inoperculate (?), diaphanous, crystalline, very fragile, microscopic, cylindrical, elongated; form of

Acicula, but malleated. 6 sp. France. *A. Simoniana*, Charp. (lxxv, 35). Is perhaps terrestrial.

LHOTELLERIA, Bourg. (Locardia, Folin.) Shell elongate-conical, apex obtuse, whorls rather convex, with impressed sutures; aperture dilated below, columellar margin oblique. *L. apocrypha*, Folin (lxxv, 36). France.

PAULIA, Bourg., 1882. 2 sp. France. *B. Berenguieri*, Bourg.

BELGRANDIA, Bourg. (Stalion, Brusina.) Like Hydrobia, but smaller, with longitudinal swellings upon the body-whorl, fainter or obsolete on those of the spire. Operculum spiral. 22 sp. Tertiary to recent. Southern Europe. *B. gibba*, Drap. (lxxii, 58).

MICROPYRGUS, Meek. Shell very small, subcylindrical, imperforate, obtuse at the apex; body-volution small, or less than half the entire length; aperture rhombic-oval, very narrowly rounded, and more or less effuse; peristome apparently not continuous; outer lip thin, simple, most prominent below the middle. Laramie beds, Dakotah. *B. minutulus*, Meek (lxxiii, 3).

PALUDESTRINA, d'Orb. (Eupaludestrina, Thalassobia, Pseudopaludinella, Bourg.) Shell conic, more or less elongated, smooth, imperforate or nearly so, apex acute; aperture ovate; peritreme continuous, outer lip acute; inner lip not thickened. Operculum corneous. Scarcely distinguishable from Hydrobia, except by its habitat. *Distr.*—Fresh water, West Indies, South America. *B. piscium*, d'Orb. (lxxii, 62).

ALBERTISIA, Issel.

Distr.—*A. punica*, Issel (lxxv, 37). Tunis.

Shell very small, cylindrical, with sutural costæ, apex obtuse; peristome continuous, reflected. Operculum unknown. May be an inoperculate shell.

MOHRENSTERNIA, Stoliczka.

Distr.—Fossil in brackish or fresh-water deposits. Eastern Europe. *M. angulata*, Esch. (lxxii, 59).

Shell turriculated, thin, semipellucid; whorls frequently transversely costulate; columella fissured at the base; aperture subovate, angulated behind, rounded in front; margin very little dilated; outer lip simple, scarcely varicose. Operculum unknown.

This, as well as the succeeding group, may be classed here temporarily, although they appear to have been aberrant members of the family, at least, if not entirely distinct.

POTAMACLIS, Sandberger.

Distr.—2 sp. Oligocene; Europe. *P. turritissima*, Forbes (lxxii, 60, 61).

Shell very long, with numerous slowly-enlarging, convex whorls; outer lip with a short sinus above. Operculum unknown.

TRICULA, Benson.

Distr.—1 sp. Fresh water, India. *T. Montana* (lxxii, 63) inhabits the river Kamaan, in India.

Shell elongated, smooth, subperforate; aperture ovate, rather narrow; inner lip thickened. Operculum corneous, nucleus very small, close to the base.

The animal has an elongated proboscis and filiform tentacles, with the eyes at their outer bases; in its thickened inner lip, the shell somewhat resembles Paludomus, but it is distinguished by its elongated spire and truncated apex.

PACHYDROBIA, Crosse and Fischer. Shell imperforate, oblong-ovate, rather thick; spire moderate, with impressed suture; aperture semicircular; peristome sinuous, continuous, thickened. Operculum subovate, thin, corneous, paucispiral. 2 sp. Fresh water, Siam, Cambodia. *T. paradoxa*, Cr. and F. (lxxii, 64).

PYRGULA, Christofori and Jan.

Syn.—Pyrgiscus, Herrmansen.

Distr.—Mountain streams, Europe, West Indies, South America. *P. helvetica*, Mich. (lxxii, 65).

Shell elongated, turreted, imperforate, four whorls, carinated; aperture oval, effuse anteriorly, outer lip not thickened. Operculum corneous, with projections on the outer margin corresponding to the concavities of the carinæ of the shell.

Foot narrow, obtuse, subbilobate in front, somewhat pointed behind, tentacles slender.

DIANA, Clessin. First whorls very small, last three nearly of equal size. *P. Thiesseana*, Clessin (lxxii, 66).

PALADILHIA, Bourg.

Distr.—7 sp. Europe. *P. pleurotoma*, Bourg. (lxxii, 67).

Shell minute, turreted, smooth; aperture expanded, peristome continuous, sinuous above and below; axis perforated.

Rivers of France. Only dead shells have been collected, so that the animal and operculum are unknown. The systematic position of the genus is doubtful. The Pleurotomoid sinus of the aperture is its remarkable feature.

LARTETIA, Bourg.

Named after the palæontologist, Edward Lartet.

Syn.—Micromelania, Brusina. Goniochilus, Sandberger.

Distr.—9 fossil, 10 recent sp. France. *L. Bourguignati*, Palad. (lxxii, 68).

Shell solid, spire elevated; peristome continuous, partly detached from the body-whorl on the left side; perforated.

BUGESIA, Paladilhe.

Distr.—*B. Bourguignati*, Palad. (lxxiii, 69).

Shell turreted, conic, with revolving grooves, and longitudinal costulæ; aperture ovate, slightly angular below and above, outer lip rounded; columella straight, compressed, not callous, slightly truncate at the base; imperforate. Operculum unknown. Microscopic. France.

BAIKALIA, Martens.

Syn.—Limnorea, Leucosia, Dybowski.

Distr.—20 sp. Lake Baikal; Colorado Desert (California). *A. Angarensis*, Gerst. (lxxiii, 70).

Shell turriculated, whorls usually convex, spire lengthened; aperture slightly angulated below. Operculum corneous, as in Hydrobia.

LIOBAIKALIA, Martens. Whorls of the spire not in contact. Form resembling Liogyrus in Valvatidæ. *B. Stiediæ*, Dyb. (lxxiii, 71).

GODLEWSKIA, Crosse and Fischer. Shell having varices. *B. turriformis*, Dyb. (lxxiii, 72).

TRACHYBAIKALIA, Martens, 1879. Shell Melaniform, longitudinally costate. *B. carinato-costata*, Dybowski (lxxxiii, 73).

With this group may also be united as a subgenus:—

TRYONIA, Stimpson. Shell perforate, elongated, turreted, subulate, acute at the summit and rather pointed at the base; surface longitudinally ribbed, plicated or cancellated, not spinose; whorls numerous, more or less shouldered; aperture small, oblique, rhombovate, somewhat pointed, effuse and sinuated at the base; outer lip thin and sharp, projecting below, inner lip appressed to the whorl above, peritreme continuous. Operculum and animal unknown. *Distr.*—Fresh water, semi-fossilized. Colorado Desert, Southern California. *B. clathrata*, Stimpson (lxxii, 74).

DYBOWSKIA, Dall., 1876. Ribs covered with a ciliated epidermis. *B. ciliata*, Dybowski. Lake Baikal.

POTAMOPYRGUS, Stimpson.

Distr.—Fresh water, New Zealand, Cuba. *P. Candeana*, d'Orb. (lxxiii, 75).

Shell ovate-conic, imperforate, apex acute, whorls coronated with spines; aperture ovate, outer lip acute. Operculum corneous. Rostrum moderate, tentacles very long, slender, tapering and pointed; eyes on very prominent tubercles; foot rather short, broadest in front and strongly auriculated.

PYRGIDIUM, Tournouer.

Distr.—Tertiary; Austria. *P. Tournoueri*, Neum. (lxxiii, 76).

Shell small, pyramidal or turreted; aperture ovately pyriform,

subeffuse at the base, angulate above; peristome continuous, thickened, duplicate.

PROSOSTHENIA, Neumayr. Shell small, ovate-conical or turreted, longitudinally plicate; last whorl coarctate, deflected; aperture ovate, oblique, entire; peristome continuous, thickened, duplicate, outer lip protracted. Tertiary; Austria. *P. Schwarzi*, Neum. (lxxiii, 77).

FOSSARULUS, Neumayr. Shell small, subglobose, rimate, with revolving nodulous ribs, and longitudinal riblets; aperture widely ovate, effuse above and below; peristome continuous, thickened, duplicate. Tertiary; Austria. *P. Stachei*, Neum. (lxxiii, 78).

AMNICOLA, Gould and Haldeman.

Distr.—United States throughout, including California. *A. limosa*, Say (lxxiii, 79).

Shell small, turbinately globose, thin, smooth, perforate or umbilicate; aperture broadly ovate, not oblique, outer lip thin and sharp, not projecting anteriorly. Operculum corneous.

Foot rather short and broad, expanded and broadly rounded behind; rostrum short; tentacles cylindrical, blunt at their tips. Ova-capsules semilenticular, with a laminiform limb, each containing a single egg.

TOXOSOMA, Conrad.

Distr.—Tertiary; So. America. *T. eborea*, Conr. (lxxiii, 1).

Shell conical, polished, the aperture projecting, subovate, direct; peristome continuous. Columella concave, with a plait or tooth in the middle, not oblique; base rounded, subumbilicated. Mr. Conrad supposed this to be a land-shell; its position in the system cannot be accurately defined.

LIOSOMA, Conrad.

Distr.—Tertiary; So. America. *L. curta*, Conr. (lxxiii, 2).

Conical, polished; aperture subelliptical; columella with one plait in the middle; base entire. Position very doubtful.

SUBFAMILY *LITHOGLYPHINÆ*.

Shell small, globose, spire short, last whorl proportionally very large; lip sharp. Fresh water.

LITHOGLYPHUS, Muhlfeldt.

Distr.—Fresh water, So. E. Europe, So. America. *L. lapidum*, d'Orb. (lxxiii, 80, 81).

Shell globular, thick, smooth, imperforate; spire short; suture not impressed; aperture broadly subovate or nearly circular, inner lip callous, outer lip simple. Operculum corneous, rounded.

Animal (of *L. lapidum*). Foot large, longer than the shell; tentacles short, rather tapering and pointed.

BENEDICTIA, Dybowski. Shell Paludiniform, very thin. Operculum spiral, corneous. *Distr.*—3 sp. Lake Baikal. *L. Baikalensis*, Gerst. (lxxiii, 82).

JULLIENIA, Crosse and Fischer. Peristome expanded. Cambodia. *L. Jullieni*, Desh. (lxxiii, 83).

GILLIA, Stimpson.

Distr.—Fresh water, Eastern United States. *G. altilis*, Lea (lxxiii, 84).

Shell rather large, subglobular, thin, subperforate, smooth; spire small, suture not impressed; aperture large, broad-ovate, oblique; outer lip thin, acute, not projecting anteriorly. Operculum thin, corneous, regularly ovate.

Rostrum rather broad; tentacles tapering, pointed. Ovacapsules hemispherical, each containing a single egg; deposited singly or in groups or linear series. Probably a synonym of the next genus.

SOMATOGYRUS, Gill.

Distr.—Fresh water, central parts of the United States. *S. depressus*, Tryon (lxxiii, 85).

Shell rather large, globular, thin, smooth, perforate, spire small, suture impressed, body-whorl globose, more or less shouldered above; aperture large, oblique, rhombovate, narrowly rounded in front and back; peritreme thin and acute, its entire margin uniformly in one plane, the outer lip not projecting anteriorly. Operculum rather thick, corneous, subovate, inner margin concave above.

FLUMINICOLA, Stimpson.

Distr.—Fresh water, Oregon and California. *F. Nuttalliana*, Lea (lxxiii, 86).

Shell comparatively large, obliquely ovate, thick, smooth, imperforate; spire moderate, obtuse; aperture ovate, inner lip flattened, callous, outer lip effuse and projecting anteriorly, so that the peritreme is not continuously in the same plane. Operculum corneous.

Rostrum rather large, tentacles tapering, foot broad.

COCHLIOPIA, Stimpson.

Distr.—Fresh water, California. *C. Rowelli*, Tryon (lxxiii, 87, 88).

Shell depressedconic; base concave and carinated; umbilicus large and deep; aperture oblique. Operculum thin, corneous, subspiral. Rostrum moderate, tentacles rather long, tapering.

LACUNOPSIS, Desh.

Distr.—3 sp Cambodia. Fresh water. *L. Jullieni*, Desh. (lxxiii, 89).

Shell depressed, solid, neritiform; base plane, with a submarginal angle; aperture small, semilunar; lip and columella greatly thickened.

SPEKIA, Bourguignat, 1881. Growth-lines oblique, crossed at right-angles by striæ; a small obsolete funicule behind the columellar lip. *L. zonata*, Woodward (lxxiii, 90, 91). L. Tanganyika, Africa.

SUBFAMILY *POMATIOPSINÆ.*

Shell and operculum as in Rissoinæ. Foot with lateral sinus. Amphibious.

POMATIOPSIS, Tryon.

Syn.—Chilocyclus, Gill.

Distr.—United States, Central America. *P. lapidaria*, Say (lxxiii, 92).

Shell elongated, perforate, smooth, whorls very convex; aperture round; peristome continuous, slightly expanded or reflected.

The animal of Pomatiopsis prefers damp locations in the vicinity of streams, but does not, like Amnicola, live habitually under water. It is an air-breather, but possessed of a true gill. Its locomotion is effected by first protruding and attaching the snout, then carrying the front of the body forward, and finally drawing the posterior parts after, a motion very like that of Assiminea and very different from Amnicola.

FAMILY ASSIMINIIDÆ.

Shell small, globose-conical, with sharp lip. Operculum paucispiral, corneous.

Animal with eyes at or near the ends of the tentacles as in the helices.

Terrestrial or amphibious.

ASSIMINEA, Leach.

Syn.—Syncera, Gray. Optediceras, Leith. Hydrocena, in part.

Distr.—Europe, Asia, America, a few species. *A. Grayana*, Leach (lxxiii, 93).

Shell not perforated or slightly slit, oval-conic, with moderate spire; aperture rounded-oval, entire; columellar lip somewhat thickened. Animal. Tentacles rather short, the eye-peduncles connate with them to their ends. The Indian species, *A. Francesiæ*, can often be seen for days together on dry land, walking or rather leaping with great rapidity like a caterpillar of the

Geometridæ. As the animal proceeds, the rostrum and the small foot are moved alternately.

PALUDINELLA, Pfeiffer. Shell turbinated, oval or depressed, umbilicated; whorls rounded; aperture subcircular, lip simple, usually continuous. Amphibious, living in marshes usually near the sea. *A. littorea*, Chiaje (lxxiii, 18).

ACMELLA, Blanford. Shell ovate, with a corneous epidermis; aperture ovate, the margin obtuse. Operculum corneous, thin, paucispiral. Animal like Assiminea, with short proboscis, tentacles short obtuse, with eyes on their sides, foot moderate, obtuse. *A. tersa*, Benson (lxxiii, 94). Damp places, Khasi hills, India. A land rissoid allied to Assiminea.

HYDROCENA, Parreyss. (Georissa, Blanf.) Shell imperforated or umbilicated, globosely turbinated; aperture oval. Operculum thin, corneous paucispiral. Dalmatia, India. Terrestrial. *A. Cattaroensis*, Pfr. (lxxiii, 95).

LAGUNCULA, Benson, 1856. (Bensonia, Cantraine.) Shell turbinated, subglobular; aperture oblong, large; outer lip a little reflected; umbilicus profound, tortuous. *A. pulchella*, Benson. Chusan.

FAMILY VALVATIDÆ.

Shell depressed conical or almost discoidal; umbilicated; covered by a thin greenish epidermis. Operculum orbicular, corneous, multispiral.

Animal with a produced muzzle; tentacles long and slender, eyes at their outer bases; foot bilobed in front; branchial plume long, pectinated, partially exserted on the right side, when the animal is walking. Lingual teeth broad; uncini 3, lanceolate; all hooked and denticulated (xi, 24).

VALVATA, Müller.

Syn.—Valvatinella, Betta. Cincinna, Hübn.

Distr.—Fresh water, mundane. *V. piscinalis*, Müll. (lxxiii, 96).

Shell depressed conical (in the typical group). Other characters, those of the family.

The species are of small size, living in ponds and ditches and slow-running water, principally in North America and Europe. When the animal is moving, the delicate, retractile branchial plume is projected over the neck. The female deposits her eggs in a single, coriaceous, spherical capsule, which is affixed to stones or the stems of aquatic plants.

GYRORBIS, Fitzinger. (Planorbitina, Betta. Planella, Schlüt.) Shell discoidal, depressed, widely umbilicated, whorls rounded. Europe, America. *V. cristata*, Müller (lxxiii, 97).

TROPIDINA, H. and A. Adams. Shell turbinated, whorls carinated. N. America. *V. tricarinata*, Say (lxxiii, 98, 99).

LYOGYRUS, Gill. (Heterocyclus, Crosse.) Spire elevated, the last whorl becoming detached from the close spiral near the aperture. U. S., New Caledonia. *V. pupoidea*, Gould (lxxiii, 100).

FAMILY PALUDINIDÆ.

Shell conical or globular, with a thick, olive-green epidermis; aperture rounded; peristome continuous, entire. Operculum horny.

Animal with a broad entire muzzle; tentacles short and rather stout; eyes on short pedicels, outside the tentacles. Inhabiting fresh waters in all parts of the world. Dentition (xi, 25).

PALUDINA, Lam.

River-snail. *Etym.*—*Palus* (*paludis*), a marsh.

Syn.—Vivipara, Montf. Viviparella, Raf.

Distr.—100 sp. Fresh water, mostly in the Northern hemisphere, Australia.* Fossil, 75 sp. World-wide. Jurassic—. *P. Bengalensis*, Lam. (lxxiv, 6).

Shell turbinated, with round whorls; aperture slightly angular behind; peristome continuous, entire. Operculum horny, concentric. Animal with a long muzzle, and very short eye-pedicels; neck with a small lappet on the left side, and a larger on the right, folded to form a respiratory siphon; gill comb-like, single; tongue short; teeth single, oval, slightly hooked and denticulated; uncini 3, oblong, denticulated. The Paludinæ are viviparous; the young continuing for some time after they are hatched within the parent shell.

PALUDINA (restricted). Whorls rounded, generally banded, rather thin, umbilicated. The European species have three bands, those of the United States four bands, whilst the numerously banded species are Oriental.

MELANTHO, Bowdich. Whorls smooth, flattened around their upper portion, generally not banded, solid, nearly or quite imperforate. Peculiar to the United States. *P. integra*, Say (lxxiv, 7).

TULOTOMA, Hald. Whorls angulated, nodulous, flattened around their upper portion. *P. bimonilifera*, Lea (lxxiv, 8).

MARGARYA, Nevill. Spire produced; whorls scalariform, with deep suture, sculptured with prominent spiral ribs; apex obtuse; rimate. Operculum and animal unknown. *Distr.*—*P. Melanoides*, Nevill (lxxiv, 9). Lake Tali, Yunnan. Closely allied to the American subgenus Tulotoma.

NEOTHAUMA, E. A. Smith. Shell with aperture effuse and slightly channeled at the base; outer lip rather deeply, yet

* There are no So. American species, nor in N. Am. west of the Rocky Mountains.

widely, sinuated in the middle. *P. Tanganyicense*, Smith (lxxiv, 10). Lake Tanganyika, Africa.

TANGANYICIA, Crosse. Shell globose, ampullariform, rimate, covered by a very thin epidermis; columellar lip lobed below. Operculum at first spiral, afterwards concentric. *P. rufofilosa*, E. A. Smith (lxxiv, 11). Lake Tanganyika.

MEKONGIA, Crosse and Fischer. Aperture contracted, appearing like a gigantic Stenothyra. Cambodia. *P. Jullieni*, Desh. (lxxiv, 12).

LARINA, A. Ad.

Syn.—Robinsonia, H. Nevill.

Shell imperforate, semiglobose, thin; spire obtuse, whorls few, tumid, covered with an olivaceous epidermis, last whorl large and ventricose; aperture wide, ovate; outer lip simple, regular, acute. Operculum annular, horny, ovate. Moreton Bay, Australia; possibly from a stream in the vicinity.

Adams thinks it is related to Paludina, but it may be a marine shell, and I have included it in the Naticidæ of this work (p. 206). Several Indian species, apparently of the same genus, have been described under the generic name of Robinsonia. *R. Ceylonica*, Nevill (lxiii, 51).

CLEOPATRA, Troschel.

Distr.—Several species. Egypt and E. Africa. *C. bulimoides*, Oliv. (lxxiv, 13).

Shell turbinate, with moderate spire. Operculum subspiral. The spire is more elevated than in Paludina, and the operculum differs.

LIOPLAX, Troschel.

Syn.—Haldemania, Tryon.

Distr.—A few United States species. *L. subcarinata*, Say (lxxiv, 14).

Shell with elevated spire, very convex, somewhat carinated or angulated whorls, and deep sutures. Operculum concentric, but with a spiral nucleus.

LIOPLACODES, Meek. Differs from Lioplax in its more elongated form, smaller body-whorl, more constricted suture, aperture angular posteriorly; peritreme continuous; umbilicate. *L. veterna*, Meek and Hayden. Jurassic; U. S.

FAMILY AMPULLARIIDÆ.

Shell globular, with large body-whorl, and more or less depressed spire; sometimes planorboid. Aperture slightly expanded. Operculum concentric.

Animal with a long siphon, formed by the left neck-lappet; left gill developed, but much smaller than the right; muzzle

produced into two long tentacular processes; tentacles extremely elongated, slender. Dentition (xi, 22, 23). Inhabits lakes and rivers throughout the warmer parts of the world, retiring deep into the mud in the dry season, and capable of surviving a drought, or removal from the water for several years. In the Lake Mareotis, and at the mouth of the Indus, Ampullariæ are abundant, mixed with marine shells. Their eggs are large, enclosed in calcareous capsules, and aggregated in globular masses around the stems of plants, etc.

These fluviatile mollusks represent in the ponds and rivers of the tropics, the Paludinæ of more temperate climates. Although distinct gills exist, the respiratory cavity is very large and partly closed, so as to enable these animals to live a long time out of water; in fact, they appear to be truly amphibious.

AMPULLARIA, Lam.

Apple-snail. *Etym.*—*Ampulla*, a globular flask.

Syn.—Pachylabra, Swains.

Distr.—150 sp. Tropical, in fresh water. West Indies, Central and South America, southern portion of the United States, Africa, India, East Indies. *A. ampullacea*, Linn. (lxxiv, 15).

Shell globular, with short spire; epidermis green, polished, sometimes banded or spotted; usually umbilicated.

Typical.—Aperture slightly thickened within the margin. Operculum with an inner calcareous layer. Oriental exclusively.

SAULEA, Gray. Shell ovate, subglobose, very thin, parchment-like, elastic, dark-colored, variegated, covered with a very thin, hard, olive epidermis; upper whorls minutely keeled, others rounded; axis imperforate. Operculum thin, shelly, elastic. Sierra Leone. *A. vitrea*, Gray.

POMUS, Humphrey. Differs from Ampullaria in the absence of a thickened internal ledge of the lip, and in the operculum being entirely horny. American exclusively. *A. canaliculata*, Lam. (lxxiv, 16).

POMELLA, Gray. Shell suboval, solid, not umbilicated; whorls striated, the last very large; spire very short or depressed; aperture very large; peristome thin, expanded. Operculum horny. South America. *A. neritoides*, d'Orb. (lxxiv, 17).

ASOLENE, d'Orb.

Syn.—Ampulloidea, d'Orb. Ampullaroides, Gray.

Distr.—South America. *A. Platæ*, d'Orb. (lxxiv, 18).

Shell subglobular, spire slightly elevated; aperture oval; the inner lip somewhat thickened, forming a continuous peristome. Operculum corneous, with an inner calcareous layer. Animal without a long respiratory siphon.

LANISTES, Montfort.

Distr.—East Africa. *L. Bolteniana*, Chemn. (lxxiv, 19).

Shell sinistral, depressed; umbilicated; peristome simple, sharp. Operculum horny.

MELADOMUS, Swainson. Shell sinistral, oval-conic, not umbilicated. Africa. *L. olivacea*, Sowb. (lxxiv, 20).

MARISA, Gray.

Syn.—Ceratodes, Guilding.

Distr.—A few species. So. America, West Indies. *M. cornuarietis*, Linn. (lxxiv, 21). *M. Chiquitensis*, d'Orb. (lxxiv, 23).

Shell flattened or planorbiform, spire depressed or very slightly elevated; widely umbilicated; aperture expanded. Operculum horny.

FAMILY TRUNCATELLIDÆ.

Shell subcylindrical or turbinate, with elevated spire, apex obtuse or truncate; aperture oval, entire, peristome continuous. Operculum subspiral.

Animal with short, diverging triangular tentacles, and eyes at their bases. Amphibious, inhabiting usually margins of streams, salt marshes, damp places, etc. The relationship of these mollusks with the Rissoids and Assiminiæ is very close, so that they may be considered as terrestial Rissoidæ; on the other hand, they connect with the typical operculated land-shells, the Cyclostomæ.

TRUNCATELLA, Risso.

Looping snail. *Syn.*—Choristoma, Crist. and Jan. Erpetometra, Lowe.

Distr.—62 sp. World-wide, mostly tropical. Fossil. Eocene; Paris basin. *T. truncatula*, Drap. (lxxv, 24).

Shell minute, cylindrical, truncated; whorls striated transversely; aperture oval, entire; peristome continuous. Operculum corneous, subspiral.

Animal with short, diverging, triangular tentacles; eyes centrally behind; head bilobed; foot short, rounded at each end.—FORBES.

The Truncatellæ are found on stones and sea-weeds between tide-marks, and survive many weeks out of the water.—LOWE. They walk by contracting the space between their lips and foot, like the geometric caterpillars.—GRAY. They are found semi-fossil along with the human skeletons in the modern limestone of Guadaloupe.

TAHEITEA, H. and A. Ad. Operculum calcareous, radiately lamellate. Aperture usually more or less separated from the preceding whorl. Polynesia. *T. Vitiana*, Pease. Viti Isles.

CECINA, A. Ad., 1861. Shell imperforate, subcylindrical, epidermis olivaceous; apex obtuse, eroded, not truncate; whorls flat, smooth; aperture ovate, vertical, rounded in front, acuminated behind; the continuous lip flexuous and subproduced in the middle. Operculum corneous, paucispiral. Tentacles lo filiform, with obtuse apices, the large eyes at their external bases. Rostrum elongate, cylindrical, annulate. Foot short, oblong. Manchuria. *T. Manchurica*, A. Ad.

GEOMELANIA, Pfeiffer.

Etym.—*Ge*, the ground (*i. e.* terrestrial), and *Melania*.

Distr.—21 sp. Jamaica. *G. Jamaicensis*, Pfr. (lxxv, 25).

Shell imperforate, turreted; aperture entire, effused; peristome simple, expanded; margins joined, basal produced into a tongue-shaped process. Operculum oval, pellucid, whorls few, rapidly enlarging.

BLANDIELLA, Guppy. Labrum without linguiform appendage. Operculum paucispiral, inner side cartilaginous, externally calcareous, rugose. 1 sp. Trinidad, W. I. *G. reclusa*, Guppy (lxxv, 26, 27).

CHITTIA, Livesay. Shell imperforate, conic, cylindrical; aperture ovate, moderately effuse, peristome thickened, sharply reflected, not produced, with a sinus on the inner side near the axis. *C. sinuosa*, Chitty (lxxv, 28). There is only the type species; but *Aciculina emarginata*, Desh., an eocene fossil of the Paris basin, may also be referred to this subgenus.

RENEA, Nevill.

Etym.—Named in honor of J. Réné Bourguignat.

Distr.—2 sp. Southern France. *R. Bourguignatiana*, Nevill (lxxv, 29, 30).

Shell imperforate, elongated-cylindrical, whorls numerous, compressed, costulate; margin of peristome obtuse, thickened within, without external marginal varix; outer lip with a pleurotomoid sinus posteriorly; columella nearly perpendicular, slightly twisted above, where it presents a superficial, channel-like indentation.

TOMICHIA, Benson.

Distr.—India, Japan, So. Africa. *T. ventricosa*, Sowb. (lxxv, 31).

Shell with elongated spire and generally truncated apex; perforated; peristome continuous, double or triple. Operculum paucispiral.

BLANFORDIA, Ad.

Etym.—Named in honor of W. T. Blanford.

Distr.—4 sp. Japan, Australia. *B. Japonica*, A. Ad. (lxxv, 32).

Shell ovately conical, epidermis olivaceous, smooth, apex

truncated; aperture elliptical, peristome continuous, thickened, duplicate, subacute within, subvaricose without. Operculum corneous, subspiral.

Rostrum elongated, transversely corrugated, emarginate in front; tentacles very short, triangular, depressed, the eyes at their bases; foot large, divided by a transverse sulcus.

Acicula, Hartmann.

Syn.—Acme, Hartmann. Pupula, Agassiz. Auricella, Jurine.

Distr.—22 sp. Europe, No. Africa. *A spectabilis*, Rossm. (lxxv, 33).

Shell minute, slender, nearly imperforate; peristome slightly thickened, margins subparallel, joined by a thin callus. Operculum very thin, transparent, paucispiral.

Family CYCLOSTOMIDÆ.

Shell spiral, rarely much elongated, often depressed, spirally striated; aperture nearly circular; peristome simple. Operculum distinctly spiral.

Animal with the eyes on slight prominences at the outer bases of the tentacles; tentacles contractile only; foot rather elongated.

Teeth recurved, hooked, in seven rows, arranged in a semilunar manner on a narrow lingual band (xi, 21). Mouth proboscidiform, not provided with horny jaws. Respiratory organ reticulate, in the form of a sacciform cavity on the back of the neck; edge of the mantle free from the nape, leaving the respiratory cavity open. Sexes distinct. Oviparous, for the most part terrestrial, and respiring free air.

The tentacles are simply contractile, and not retractile by inversion as in the Helicidæ, and the eyes are usually sessile on the head near the bases of the tentacles, instead of being elevated on peduncles as in that family.

The animal of the Cyclostomidæ is very like that of the periwinkle (Littorina), differing chiefly in the situations it inhabits and the medium respired. The operculum presents many beautiful modifications of structure characteristic of the smaller groups, which are often peculiar to limited regions, as in the Helicidæ. The oldest fossil species are Eocene.

I. *Pomatiasinæ.*

Pomatias, Studer.

Distr.—80 sp. So. Europe, several in N. Africa and India. *P. obscurus*, Lam. (lxxv, 38).

Shell slender, turreted, longitudinally striated; peristome subcontinuous, reflected. Operculum cartilaginous, paucispiral, composed of two plates and concamerated between them.

HAGENMUELLERIA, Bourg., 1882. 2 sp. Algiers. *P. Pechaudi*, Bourg.

CARDIOSTOMA, Sandberger. *P. trochulus*, Sandb. Eocene Europe.

REALIA, Gray.

Syn.—Liarea, Gray. Hydrocena, Auct. (in part).

Distr.—25 sp. Mauritius, Philippines, Polynesia. *R. egea*, Gray (lxxv, 39).

Shell turreted or turbinate, nearly smooth; perforated; aperture oval; peristome continuous, straight or expanded. Operculum paucispiral, thin, corneous.

CYCLOMORPHA, Pease. Shell turbinate, subglobose, solid, smooth, or spirally striate, perforate; aperture nearly circular; peristome simple, somewhat thickened, connected on the columellar side by a thin callus. Operculum paucispiral. 2 sp. Polynesia. *R. flava*, Brod. (lxxv, 40).

OMPHALOTROPIS, Pfeiffer. Shell turreted or globosely turbinated, carinated around the umbilical perforation; aperture oval; peristome expanded or simple. Polynesia. *R. rubens*, Quoy (lxxv, 41, 42).

JAPONIA, Gould, 1859. Globosely conical, whorls contiguous, but scarcely impinging; umbilicus open; decussated by lamellar growth-lines and revolving liræ. Operculum thin, paucispiral. 3 Japanese species. *R. musiva*, Gld.

SCALINELLA, Pease. Shell scalariform, narrowly perforate; whorls rounded, longitudinally costate, suture profound; lip subcircular, continuous, barely or not in contact, simple. Polynesia. *R. Taheitensis*, Pease (lxxv, 43).

ATROPIS, Pease. Shell elongate, sometimes cylindrical, rarely ovate, imperforate, in the species of ovate form narrowly perforate; aperture ovate, occasionally circular; peristome continuous, sometimes disconnected from the penultimate whorl and very slightly porrected. Last whorl frequently obtusely angulate on its periphery, of one color, usually pale yellow or reddish. Polynesia. *R. Caledonica*, Crosse (lxxv, 44).

II. *Pupinea.*

PUPINA, Vignard.

Syn.—Eupupina, Pfr. Moulinsia, Grat.

Distr.—42 sp. East Indies, Japan, Philippines, Australia. *P. bicanaliculata*, Sowb. (lxxv, 45).

Shell subcylindrical, usually polished; aperture circular, peristome thickened, notched in front and at the suture. Operculum membranous, narrow-whorled.

REGISTOMA, Van Hasselt. (Rhegostoma, Agassiz). Shell pupiform, thin, transparent, smooth, polished; whorls displaced, apex papilliform; peristome reflected, with a narrow channel

in the middle of the columellar side. *P. grande*, Gray (lxxv, 46, 47).

CALLIA, Gray. Shell smooth, shining, pupiform; aperture without sinus; peristome simple, thin. *P. lubrica*, Sowb. (lxxv, 48).

HARGRAVESIA, H. Adams. (Hyalopsis, Pease.) Shell like Pupina, but anterior marginal slit or canal absent, distinctly channeled posteriorly. *P. polita*, H. Ads. (lxxv, 50).

PUPINELLA, Gray.

Distr.—13 sp. East Indies, Formosa, Philippines, Australia, etc. *P. pupiniformis*, Sowb. (lxxv, 51, 52).

Shell oval-oblong, covered with a thin, corneous epidermis; aperture circular; peristome thick, reflected, slit on the anterior left side and canaliculate at the suture. Operculum corneous, multispiral.

PUPINOPSIS, H. Adams, 1866. Peristome tubularly prolonged on the penultimate whorl. *P. Swinhoei*, H. Ad. Formosa.

RAPHAULUS, Pfeiffer.

Syn.—Anaulus, Pfeiffer.

Distr.—5 sp. East Indies. *R. bombycinus*, Pfr. (lxxv, 53).

Shell umbilicated, pupiniform, peristome double, internal continuous, external dilated, perforated at the margin by a canal; canal sutural and internal, terminating anteriorly, and embraced by the outer portion of the double peristome (it can be traced externally along the last whorl), and reaching into the concavity of the spire. Operculum very thin, corneous; narrow-whorled.

"The use of the sutural tube seems to be the preservation of a communication with the external air when the aperture is closed."—BENSON.

STREPTAULUS, Benson. Shell pupiniform, shining, peristome circular, not continuous, with a subsutural internal tube, which is reflexed at the aperture and runs along the suture externally. 1 sp. Himalayas. *R. Blanfordi*, Benson (lxxv, 54).

CATAULUS, Pfeiffer.

Distr.—17 sp. Ceylon. *C. pyramidatus*, Pfr. (lxxv, 55).

Shell pupa-shaped, with the base keeled, producing a channel in the front of the aperture. Operculum circular, horny, the whorls easily separable. Represents in Ceylon a group approaching Megalomastoma. The whorls of the operculum, when macerated, separate and may be unrolled in spiral form.

TORTULOSA, Gray. Last whorl solute. Nicobar. *C. tortuosa*, Chemn. (lxxv, 56–58).

MEGALOMASTOMA, Guilding.

Syn.—Lomastoma, Woodward.

Distr.—29 sp. W. Indies, E. Indies, India, Madagascar, Mauritius. Fossil. Eocene—. Paris and Isle of Wight. *M. Antillarum*, Sowb. (lxxv, 59).

Shell oblong or pupa-shaped, scarcely perforated, aperture circular. Operculum thin, horny, many-whorled, flat.

FARCIMEN, Troschel. Lip thickened. W. Indies. *M. ventricosum*, d'Orb. (lxxv, 60).

MEGALOMASTOMA, Guild. Lip rather thin. W. Indies.

COPTOCHEILUS, Gould. Narrowly perforate; aperture slightly touching or not touching the body-whorl; peristome not thickened, more or less duplicate. E. Indies. Scarcely distinct from Megalomastoma (restricted). *M. altum*, Sowb. Philippines.

TOMOCYCLUS, Crosse and Fischer. Shell perforate, turreted, truncate; aperture subcircular, small; peristome duplex, the inner margin direct, the outer margin widely expanded, excised above. Operculum with a median posterior rounded process, margins of the whorls sublamellate. Central America, Guatemala. *M. simulacrum*, Morel. (lxxv, 61).

HAINESIA, Pfeiffer, 1856.

Syn.—Mascaria, Angas.

Distr.—4 sp. Madagascar, Siam. *H. Myersi*, Haines.

Shell oblong-turreted, whorls convex, without epidermis, resembling Megalomastoma. Operculum angular, paucispiral.

DACRYSTOMA, Crosse and Fischer, 1871. Whorls flattened, with very thin, deciduous epidermis. *H. arboreum*, C. and F. Madagascar.

DIPLOMMATINA, Benson.

Distr.—100 sp. India, East Indies, Australia, Polynesia. *D. folliculus*, Pfr. (lxxv, 62, 63).

Shell suboval, costulate, dextral or sinistral, thin, scarcely perforated; aperture subcircular; peristome double, outer margin expanded. Operculum horny, multispiral. The eyes are situated on the hind-part of the tentacles, at their base, and are composed of two lobes, one lobe deeply seated in the tentacle and larger than the other lobe, which is a small black point coming to the surface on the outer side of the larger lobe. The generic name is derived from this peculiarity of the eyes.

PAXILLUS, H. and A. Adams. Shell small, pupiform, sinistral, rimate; spire pointed; aperture semiovate, ascending on the body-whorl; inner lip spreading, 1-plaited, outer lip expanded, notched in front; umbilicus defined by a rib. *D. rubicunda*, Martens (lxxv, 64).

DIANCTA, Martens. Penultimate whorl constricted. *D. constricta*, Martens (lxxv, 65, 66).

NICIDA, Blanford. Shell smooth or spirally striate, imperforate. Operculum corneous, subobsoletely multispiral. *D. Niligirica*, Blanf. (lxxv, 67).

PALAINA, Semper. (Pupoidea, Pease.) First two or three whorls much smaller than the others (deciduous?). Operculum membranaceous, multispiral. *D. scalariformis*, Pease (lxxv, 68).

CLOSTOPHIS, Benson, 1860. Shell subbiconical; the penultimate whorl large, the last descending, solute, subaxial, small; aperture with continuous peristome, and parietal tooth. Operculum unknown. *D. Sankeyi*, Benson. Caverns near Moulmein.

MOUSSONIA, Semper. Peristome nearly continuous with a tooth upon the centre of the left margin. *D. typica*, Semper (lxxv, 69).

ARINIA, H. and A. Adams. Shell subimperforated, thin, smooth, shining, turriculated, obtuse at the summit, last whorl swollen; aperture subcircular; margin nearly continuous; columellar lip angularly dilated in the middle. Operculum thin, calcareous, paucispiral. *D. minor*, Sowb. (lxxvi, 70).

OPISTHOSTOMA, Blanford.

Syn.—Plectostoma, Adams. Scoliostoma, Crespigny.

Distr.—5 sp. India, Borneo, West Africa. *O. Fairbanki*, Blanford (lxxvi, 71).

Shell pupiform, umbilicated, with a regular costulated ornamentation; apical whorls obliquely distorted; last whorl strangulated, separated from the others, and applied to the penultimate; peristome double, free portion prolonged backwards. Operculum horny (?).

O. De Crespigni, Adams (Plectostoma), has a conical spire, and the apical whorls are not excentric to the axis of the lower whorls.

III. *Cyclostomea.*

ADAMSIELLA, Pfeiffer.

Distr.—16 sp. West Indies.

Shell pupiform or oblong-turreted; aperture small, subcircular; peristome usually double, more or less expanded or reflected. Operculum thin, rather cartilaginous, whorls few, with subcentral nucleus. *A. mirabilis*, Wood (lxxvi, 72).

DIPLOPOMA, Pfeiffer.

Distr.—*D. architectonicum*, Gundl. (lxxvi, 73, 74).

Shell oblong-turreted. Operculum subduplicate, acutely separated at the margin; inner layer concave, smooth; outer layer inflated, calcareous, paucispiral, nucleus profoundly immersed.

CTENOPOMA, Shuttleworth.

Distr.—26 sp. West Indies. *C. bilabiatum*, d'Orb. (lxxvi, 75, 76).

Shell ovate or cylindrically turreted, truncate; aperture subcircular; peristome expanded, mostly duplicate; umbilicate or perforate. Operculum testaceous, rather narrowly spiral, the whorls obliquely sulcate, nucleus nearly central.

CYCLOTOPSIS, W. T. Blanford.

Distr.—3 sp. India, Mauritius. *C. semistriata*, Sowb. (lxxvi, 77).

Shell widely umbilicate, turbinately depressed, spirally lirate; aperture subcircular. Operculum multispiral, duplex, membranaceous within, testaceous externally with the margins of the whorls elevated.

CHOANOPOMA, Pfeiffer.

Distr.—55 sp. W. Indies. *C. lima*, C. B. Ad. (lxxvi, 78, 79).

Shell globular-turbinated or turreted, spire frequently truncated; aperture suboval or circular; peristome usually double, reflected. Operculum testaceous, the margins of the whorls usually free, ribbed.

LICINA, Gray. Last whorl sometimes detached near the aperture; peristome subreflected. *C. evoluta*, Reeve (lxxvi, 80).

JAMAICEA, C. B. Adams. Shell umbilicated, globular-conic; peristome simple or double, straight or reflected. Operculum externally convex, its whorls obliquely striated, sublamellar. *C. anomala*, Ad. (lxxvi, 81).

CHONDROPOMA, Pfeiffer.

Distr.—100 sp. West Indies. *C. magnificum*, Sallé (lxxvi, 82).

Shell oblong-turreted, or globular-turbinated, frequently the apex is truncated; aperture oval; lip simple or more or less double, nearly direct, a little expanded or reflected. Operculum oval, subcartilaginous, flat, paucispiral.

CISTULA, Gray.

Distr.—42 sp. West Indies and neighboring continent. *C. Sauliæ*, Sowb. (lxxvi, 83).

Shell globular-conic or oval, or oblong-turreted, apex usually truncated; aperture oval; peristome single or double, reflected. Operculum thin, cartilaginous, paucispiral, with rapidly enlarging whorls.

TUDORA, Gray.

Distr.—34 sp. West Indies and neighboring continent. *T. mumia*, Lam. (lxxvi, 84).

Shell oval-oblong or turreted; aperture oval, angular posteriorly; peristome single or double, expanded. Operculum oval,

testaceous externally, flat, paucispiral; the whorls obliquely sillonated or striated, nucleus very excentric.

LEONIA, Gray. Peristome simple, subreflected. Operculum oval, calcareous, unispiral, convex externally, nucleus lateral, near the columellar lip. *T. mamillaris*, Lam. (lxxvi, 85). Southern Europe.

CYCLOSTOMA, Lam.

Etym.—*Cyclos*, circle, and *stoma*, mouth.

Distr.—120 sp. About half in Madagascar, a few in the East and West Indies, two or three in Europe. *C. sulcatum*, Lam. (lxxvi, 86). *C. elegans*, Müll. (lxxvi, 87).

Shell globular-conic or turriculated, thin, more or less widely umbilicated; aperture subcircular; peristome single or double, straight or slightly reflected. Operculum calcareous, paucispiral, flattened, nucleus excentric.

Animal with clavate tentacles; sole of the foot divided by a longitudinal groove, the sides moved alternately in walking; the end of the long muzzle is also frequently applied, as by the looping-snails (Truncatellæ), and used to assist in climbing.

TROPIDOPHORA, Troschel. Shell depressed turbinate, widely umbilicated or imperforate, with revolving carinæ and striæ; lip reflected, sometimes covering a part of the umbilicus. A group of usually large species inhabiting Madagascar. *C. Cuvierianum*, Petit (lxxvi, 88).

LITHIDION, Gray. Shell depressed, widely umbilicated; aperture subcircular; peristome simple, thin or thickened. Operculum paucispiral, with a strong subcentral carina. *C. lithidion*, Sowb. (lxxvi, 89).

REVOILIA, Bourguignat, 1881. (Dedicated to M. Georges Révoil.) Shell depressed, discoidal, spirally ridged; umbilicus wide in young individuals, but entirely closed in adults by a thin dilation of the columellar lip; peristome continuous, dilated-reflexed, the lip slightly ascending against the body-whorl above. *R. Milne-Edwardsi*, Bourg. E. Africa. Closely allied to Lithidion.

OTOPOMA, Gray. Shell subglobose, umbilicated; peristome simple or a little reflected, with an ear-like process covering part of the umbilicus. Operculum convex in the middle. 19 sp. Socotra, Madagascar, Zanzibar, Mauritius, India. *C. Naticoides*, Recl. (lxxvi, 90).

LIGATELLA, Martens. Shell rounded, turbinate-conical, usually banded; peritreme simple. Cape of Good Hope, Mauritius, Madagascar. *C. ligatum*, Müll. (lxxvi, 91).

GEORGIA, Bourguignat, 1882. (Dedicated to Georges Révoil.) Umbilical region entirely covered by a callous expansion of the inner lip, which is not continuous with the labrum above. Operculum perforated in the centre, interiorly concave, spiral, covered by a mucilaginous membrane, externally convex, four-whorled,

the whorls rapidly increasing, thickened along the canaliculated suture and terminating in a tongue-like, narrow projection, appressed to the circumference of the last whorl. *C. Naticoides*, Recluz. Several species, East Africa.

ROCHEBRUNIA, Bourguignat, 1882. (Dedicated to Dr. Rochebrune, of the Museum, Paris.) Inner lip without umbilical dilation, so that the umbilicus is open. *C. Philippianum*, Pfeiffer. 11 sp. East African region.

IV. *Cyclophorea.*

Operculum thin, corneous, multispiral. The animals of this extensive group are found in the humid parts of tropical forests, either concealed among the débris at the roots of trees, or inhabiting the branches and foliage; some, however, prefer dry and arid situations, while others take up their abode in the immediate vicinity of the sea.

CYCLOPHORUS, Montfort.

Etym.—*Cyclos*, circle, *phoreus*, bearer.

Distr.—200 sp. Tropical, mundane. *C. volvulus*, Müll. (lxxvi, 92).

Shell depressed, openly umbilicated; aperture circular; peristome continuous, straight or expanded; epidermis thick. Operculum horny, many-whorled.

Animal with long, slender, pointed tentacles; foot broadly expanded, not grooved.

MYXOSTOMA, Troschel. Shell discoidal, widely umbilicated; peristome double, the internal margin continuous, external margin reflected, and produced into a tongue-like form posteriorly. *C. Troscheli*, Benson (lxxvi, 93).

THEOBALDIUS, Nevill. Shell subdiscoidal, widely umbilicated; peritreme circular, thickened, not much reflected, continuous. Asiatic. *C. annulatus*, Nevill (lxxvi, 94).

SCABRINA, Blanford. Shell depressed, subdiscoidal, widely umbilicated; epidermis hispid; whorls rounded; aperture circular, peristome thickened. Operculum thick, corneous, the margins of the whorls lamellately elevated. Asiatic. *C. calyx*, Benson (lxxvi, 95).

BUCKLEYIA, Higgins. Shell discoidal, widely umbilicated; with revolving carinæ, and deciduous epidermis; aperture circular, vertical, margin continuous, adnate, thin, acute. So. America. *C. Martinezi*, Hidalgo (lxxvi, 96, 97).

MICRAULAX, Theobald. Proposed for planorboid species uniting the Myxostoma type with the turbinate Lagocheilus.

LAGOCHEILUS, Blanford. Shell conoid-subturbinate, perforated, thin; aperture round, with a narrow incision in the posterior angle. Operculum thin. Animal with a glandular slit at the

upper posterior end of the foot. Indian. *C. tomotrema*, Benson (lxxvi, 98).

DITROPIS, Blanford. Shell subvitreous, translucent, with revolving carinæ, one of which is on the periphery. Operculum with the margins of the whorls raised. Indian. *C. convexus*, Blanf. (lxxvi, 99).

ACROPTYCHIA, Crosse and Fischer. (Euptychia, C. and F.) Shell globosely turbinate, thin, longitudinally ribbed; aperture subovate-circular, the margin shortly expanded; umbilicated. Operculum corneous, paucispiral. 1 sp. Madagascar. *C. metableta*, C. and F. (lxxvi, 100, 1).

Leptopoma, Pfeiffer.

Distr.—65 sp. E. Indies, Philippines, Australia. *L. perplexum*, Sowb. (lxxvi, 2.) *L. acutimarginatum*, Pfr. (lxxvi, 11).

Shell turbinated, globular or conic, narrowly umbilicated; aperture rounded; peristome nearly continuous, single or double, reflected. Operculum flattened, membranous.

DERMATOCERA, H. and A. Adams. Animal with a conical epidermal horn on the hind-part of the foot. *L. vitreum*, Lesson (lxxvi, 3, 4).

LEUCOPTYCHIA, Crosse. Shell thinly costate longitudinally, and with several spiral striæ. *C. Tissotianum*, Crosse (lxxvi, 5).

Aulopoma, Troschel.

Distr.—4 sp. Ceylon. *A. Itieri*, Guerin (lxxvi, 6).

Shell depressed, turbinated or subdiscoidal, the last whorl anteriorly detached; peristome free, straight, continuous. Operculum corneous, larger than the aperture of the shell, and having a circular groove to receive the margin of the latter.

Craspedopoma, Pfeiffer.

Syn.—Bolania, Gray.

Distr.—9 sp. Canaries, Madeira. *C. lucidum*, Sowb. (lxxvi, 7).

Shell subturbinated, rimate, the last whorl subcontracted anteriorly. Operculum round, horny, externally plane, internally concave with a submarginal ridge.

V. *Cyclotea.*

Operculum more or less thick, formed of two lamina, internally corneous, externally calcareous, multispiral.

Cyathopoma, Blanford.

Distr.—10 sp. India, Mauritius, Seychelles. *C. Deccanense*, Blanf. (lxxvii, 8, 9).

Shell minute, umbilicated, turbinated, or somewhat depressed; epidermis thick, sometimes hispid, smooth, spirally striated, or

lirated. Operculum truncate, conoid, concentric, multispiral; internally membranous, externally shelly; external margins of the whorls raised in the form of shelly plates, incurved; sometimes sculptured.

Animal white, with a short oval foot, undivided beneath; tentacles small, black, with eyes at the base.

CYCLOTUS, Guilding.

Syn.—Poteria, Gray.

Distr.—120 sp. Tropical, world-wide. *C. planorbulus*, Lam. (lxxvii, 10).

Shell subdiscoidal, very widely umbilicated; aperture circular, entire; peristome straight or sometimes reflected. Operculum orbicular, calcareous, a little concave exteriorly.

APEROSTOMA, Troschel. Peristome forming a posteriorly projecting angle, not reflected. Operculum with ridged whorls. *C. asperulus*, Sowb.

CYRTOTOMA, Mörch (Adams). Last whorl free, cylindrical; aperture rounded, the left margin dilated, angulated and produced posteriorly. *C. Mexicanus*, Menke (lxxvii, 12).

AMPHICYCLOTUS, Crosse and Fischer. Operculum horny, multispiral, with a central, wart-like projection inside. Type, *C. Boucardi*, Sallé. Mexico.

OPISTHOPHORUS, Benson.

Distr.—16 sp. Siam, Java, Borneo, Sumatra. *O. biciliatus*, Mouss. (lxxvii, 13).

Shell depressed, widely umbilicated; suture with a small open tube; peristome double. Operculum calcareous, rather thick, double, with concamerations between the two disks, which are both concave, the interior one with a corneous epidermis.

MICHOPOMA, Blanford. Shell turbinate; epidermis fuscous, thick, hirsute; aperture corrugate within. Operculum multispiral, calcareous without, corneous within. 2 sp. India. *O. hirsutus*, Beddome (lxxvii, 14).

RHIOSTOMA, Benson.

Etym.—*Rhion*, a promontory.

Distr.—6 sp. Siam, Cochin China. *O. Haughtoni*, Benson (lxxvii, 15).

Shell subdiscoidal, broadly umbilicated; last whorl separate, laterally descending; aperture free, with an incision at the top, and a subtubular prominence crowning the slit. Operculum multispiral.

CYCLOSURUS, Morelet, 1881. Shell with three embryonal spiral whorls, then disjoined and becoming tubular; aperture circular, peristome continuous, simple. Operculum corneous, multispiral.

The separation of the whorls commenced in Rhiostona, here becomes very striking. A sufficiently large number of specimens were obtained to show that this is a normal form. *Syn.*—(?) Orygoceras, Brusina, 1882. *Distr.*—*C. Mariei*, Morel. (lxxvii, 16). Mayotte Isl. Fossil. Miocene; Dalmatia.

PTEROCYCLOS, Benson.

Syn.—Steganostoma, Troschel.

Distr.—26 sp. India, China, East Indies. *P. anguliferus*, Souleyet (lxxvii, 17, 18).

Shell subdiscoidal, widely umbilicated; peristome expanded, produced into a little wing at the suture. Operculum thick, composed of a number of calcareous spiral laminæ.

SPIRACULUM, Pearson. Distinguished by the possession of a retroverted sutural tube open at both ends, and by a modification of the form of the mantle corresponding to the same. 5 sp. India. *S. hispidum*, Benson (lxxvii, 19, 20).

DIADEMA, Pease. (Garrettia, Pease.) Shell globosely turbinate, umbilicated; peristome continuous, simple, subcircular, free or scarcely adnate. Operculum subcartilaginous, elevately spirally lamellar, concave within, widely reflected at the base. 3 sp. Polynesia. *D. parva*, Pease (lxxvii, 21).

CŒLOPOMA, A. Ad.

Distr.—*C. Japonicum*, A. Ad. (lxxvii, 22, 25). Japan.

Shell subdiscoidal, widely umbilicated; peristome simple, subangulated above. Operculum elate, conical, concave, corneous, spiral.

ALYCÆUS, Gray.

Distr.—54 sp. India, East Indies. *A. gibbus*, Fer. (lxxvii, 23).

Shell conical or depressed; whorls rounded, with profound sutures; last whorl ventricose, strangulated, and tortuous near the rounded aperture; peristome double, the exterior edge reflected. Operculum corneous, multispiral.

HYBOCYSTIS, Benson.

Syn.—Pollicaria, Gould (in part).

Distr.—3 sp. Burmah, Siam, Cambodia. *H. gravida*, Benson (lxxvii, 24).

Shell pupiform; peristome continuous, reflected, with a superior process. Operculum multispiral, calcareous, with four or five whorls externally, and one and a half whorls internally.

Family Relations Doubtful.

CHONDRELLA, Pease.

Distr.—3 sp. Central Polynesia. *C. parva*, Pease, Taheiti.

Shell globosely conical, rather thin, striate, imperforate or

rimate: aperture subcircular; peristome simple, thin, margins widely separated; columella callously appressed, widely dilated. Operculum testaceous, smooth and flat externally, the nucleus obsolete, slightly concave and costate within.

Animal without tentacles, the eyes immersed in the top of the head.

FERUSSINA, Grateloup.

Etym.—Named in honor of Baron Ferussac.

Syn.—Strophostoma, Desh.

Distr.—Fossil. Miocene; Europe. *F. tricarinata*, Braun (lxxvii, 36, 27).

Shell oval-globular, or subturbinate; aperture turned upwards and applied to the side of the spire, rounded; peritreme continuous; umbilicus open, frequently bordered by a spiral keel.

SCOLIOSTOMA, Braun. Shell turriculated; aperture rounded turned up upon the spire, entire; lip thick, varicose, reflected *F. megalostoma*, Sandb. (lxxvii, 50).

THYROPHORELLA, Greef, 1882.

Distr.—*T. Thomensis*, Greef. Island of St. Thomas, W. Coast of Africa.

Shell sinistral, thin, transparent, nearly orbicular, with a slight yellowish epidermis; umbilicated; whorls sharply keeled; aperture half-round, with sharp simple margin; furnished with an operculum, connected or hinged to the shell instead of being a separate growth of the animal—so that the shell is a true terrestrial bivalve; the operculum being pushed open like a door for the exclusion of the animal and shutting upon it when withdrawn; the lines of sculpture of the shell are also continued without break upon the surface of the operculum. Terrestrial.

The animal is not described, although the author states that two of the five specimens obtained contained the soft parts. Not figured.

FAMILY HELICINIDÆ.

Shell turbinated, subglobose or depressed; columella generally very callous; aperture semilunar, with a thick, simple lip; umbilicus covered by the columellar callus. Operculum suboval or subtriangular, testaceous or corneous, mostly lamellar.

Lingual teeth with a single central, flanked on each side by three laterals (xii, 43). Head proboscidiform; tentacles subulate, with the eyes at their outer bases. Foot elongated.

The tentacles are more slender and produced and the caudal extremity of the foot is more elongate than in the Cyclophoridæ; the operculum, moreover, is formed on an entirely different plan, and the aperture of the shell, instead of being circular, is semilunar in outline. In their habits they are very similar to the

animals of the Cyclophoridæ, but are considerably more locomotive and lively; in common with some other mollusks, as the Neritidæ and Ellobiidæ, they possess the faculty of removing the inner septa and columella of the shell.

HELICINA, Lam.

Syn.—Ampullina, Blainv. Pitonillus, Montf.

Distr.—350 sp. West Indies, tropical America, Pacific Islands, Australian Islands, Philippines. *H. variegata*, Orb. (lxxvii, 28).

Shell globose, depressed or keeled, callous beneath; aperture squarish or semilunar; columella flattened; peristome simple, expanded. Operculum shelly or membranous, squarish or semi-ovate, lamellar.

OLIGYRA, Say. Shell subglobular or conic, spire and last whorl of about equal height, peristome expanded. *H. occulta*, Say. United States.

PACHYSTOMA, Swainson. Shell conically depressed, carinated. *H agglutinans*, Sowb. (lxxvii, 29, 30).

PŒNIA, H. and A. Adams. Peristome subdentate interiorly. *H. depressa*, Gray (lxxvii, 31).

IDESA, H. and A. Adams. Peristome simple, sharp. *H. rotunda*, Orb. (lxxvii, 32).

EMODA, H. and A. Adams. Peristome simple, thick, obtuse. *H. festiva*, Sowb. (lxxvii, 33).

PERENNA, Guppy, 1867. Shell depressed, whorls lirate and carinate. Operculum thin, suboval, concentrically striate, nucleus subcentral. *H. lamellosa*, Guppy. Isl. Trinidad.

DAWSONELLA, Bradley. Aperture small, lip thickened within, columella with a wide-spreading linguiform callus covering the axis. Carboniferous; United States. *H. Meeki*, Bradley (lxxvii, 34).

TROCHATELLA, Swainson.

Distr.—34 sp. West Indies. *T. constellata*, Morel. (lxxvii, 35).

Shell trochiform or globular-conic; aperture subtriangular; peristome simple, expanded; base not callous.

VIANA, H. and A. Adams. (Rhynchocheila, Shutt. Hapata, Gray.) Shell subcarinated; lip with a superior sinus. *T. regina*, Morel. (lxxvii, 36).

SCHAZICHEILA, Shuttleworth.

Distr.—5 sp. West Indies, Central America. *S. alata*, Menke (lxxvii, 37, 38).

Shell with spiral epidermal fringes; peristome profoundly incised at the suture. Operculum thin, testaceous, with an intramarginal rib.

ALCADIA, Gray.

Distr.—28 sp. West Indies. *A. Brownii* (lxxvii, 39).

Shell Helix-shaped, often velvety, callous beneath; columella flattened, straight; peristome slit in front. Operculum shelly, semiovate, with a tooth-like process adapted to the slit in the peristome.

LUCIDELLA, Swainson.

Distr.—5 sp. West Indies. *L. aureola*, Fer. (lxxvii, 40).

Shell depressed, heliciform, slightly callous at the base; aperture triangular, sinuous; peristome thickened, with superior and inferior tooth-like internal laminæ. Operculum membranous.

BOURCIERA, Pfeiffer.

Distr.—2 sp. Equador. *B. heliciniformis*, Pfr. (lxxvii, 41, 42).

Shell heliciniform, subglobose; aperture oval; peristome expanded, produced at the base. Operculum paucispiral, corneous.

Bourciera absorbs away the inner whorls of the shell, like Helicina; its dentition also agrees with that group.

STOASTOMA, C. B. Adams.

Etym.—*Stoa*, pillared, *stoma*, mouth.

Syn.—Hemicyclostoma, C. B. Ad.

Distr.—83 sp. One in Isle of Opara, Philippines, one in Hayti; all the others in Jamaica. *S. pisum*, C. B. Ad. (lxxvii, 43).

Shell minute, globose-conic or depressed, spirally striated; aperture semioval; peristome continuous; inner margin straight, forming a small spiral keel round the umbilicus. Operculum shelly, lamellar.

ELECTRINA, Gray. Shell smooth. *S. succinea*, Sowb. (lxxvii, 44), is the only species.

WILKINSONÆA, Chitty, 1857. Shell subdiscoidal, spirally carinated, last whorl much produced. *S. Wilkinsoneanum*, Chitty.

FADYENIA, Chitty, 1857. Shell with the spire depressed, subangular on the upper part of the last whorl, subplanate at the periphery, subangulated below, and subplanate round the umbilicus. *S. Fadyenianum*, C. B. Ad.

METCALFEIA, Chitty, 1857. Shell depressed conic. *S. Metcalfeianum*, Chitty.

PETITIA, Chitty, 1857. Shell globose, discoid. *S. Petitianum*, C. B. Ad.

LINDSLEYA, Chitty, 1857. Shell globose, conic. *S. Lindsleyanum*, C. B. Ad.

BLANDIA, Chitty, 1857. Shell subdiscoidal. *S. Blandianum*, C. B. Ad.

LEWISIA, Chitty. Shell subdiscoidal; aperture semiovate; peristome continuous, with a spiral callus at the base excessively

developed, usually soldered by its extreme edge to the last whorl, and forming over the umbilicus an arch, having the opening larger than the aperture of the shell. *S. Philippiana*, C. B. Ad. (lxxvii, 45, 46).

PROSERPINA, Guilding.

Syn.—Odontostoma, d'Orb.

Distr.—7 sp. West Indies, Northern So. America. *P. depressa*, d'Orb. (lxxvii, 47).

Shell orbicular-depressed, polished, covered at the base by a shining callus; aperture semioval, lip sharp; columella and parietal wall with dentiform lamellæ. No operculum.

PROSERPINELLA, Bland, 1865. Columellar fold absent; having a single parietal tooth. *P. Berendti*, Bld. Mexico.

CYANE, H. Ad., 1870. Columella truncate below. *P. Blandiana*, Ad. Peru.

CERES, Gray.

Distr.—2 sp. Mexico. *C. eolina*, Duclos (lxxvii, 49). Shell heliciniform, carinated at the periphery, upper surface rugose, epidermis thin, callous at the base; lip sharp, with spiral laminæ within the aperture; columella with dentiform laminæ.

ORDER SCUTIBRANCHIATA.

Branchiæ pectinated, placed in a cavity in the upper part of the neck, or at the inferior edge of the mantle, around the foot. Diœcious.

Shell usually spiral (globular or pyramidal) or conical, holostomate.

Suborder PODOPTHALMA. Shell spiral. Operculum usually present and paucispiral or multispiral. Eyes on peduncles, separate from the tentacles.

Suborder EDRIOPTHALMA. Shell conical, not spiral; no operculum; eyes sessile.

SUBORDER *PODOPTHALMA.*

FAMILY NERITIDÆ.

Shell thick, semiglobose, porcellanous; spire very small; cavity simple, from the absorption of the internal portions of the whorls; aperture semilunate; columellar side expanded and flattened; outer lip acute. Operculum shelly, subspiral, articulated.

At each end of the columella there is an oblong muscular impression, connected on the outer side by a ridge, on which the operculum rests; within this ridge the inner layers of the shell are absorbed.

Animal with a broad, short muzzle, and long slender tentacles; eyes on prominent pedicels, at the outer bases of the tentacles;

foot oblong, triangular. Lingual dentition similar to the Turbinidæ. Teeth 7; uncini very numerous (xii, 44, 45).

NERITA, Linn.

Etym.—*Nerites*, a sea-snail, from Nereis.

Distr.—Over 200 sp. Nearly all warm seas. West Indies, Red Sea, Zanzibar, Philippines, Australia, Central Pacific, West America. Many of the American species dwell in the streams; one species at the Philippines sometimes climbs up trees.

Fossil, 60 sp. Lias—; Britain, etc. The palæozoic Nerites are referred by d'Orbigny to Turbo, Natica, etc.

N. polita, Linn. *N. peleronta*, Linn. *N. histrio*, Linn. *N. undata*, Linn. (lxxviii, 51–54).

Shell thick, smooth or spirally grooved; epidermis horny; outer lip thickened and sometimes denticulated within; columella broad and flat, with its inner edge straight and toothed. Operculum shelly.

Animal with the mantle-margin festooned. Living on rocks and stones, and said to be most active during the night, when they roam about, feeding on the algæ; their eggs are ovate, covered with a horny skin, and attached to other shells.

PELERONTA, Oken. (Pila, Klein. Ritena and Tenare, Gray.) Inner lip rugose, outer lip dentate within. *N. Deshayesii*, Recluz (lxxviii, 55).

THELIOSTYLA, Mörch. (Natere, Gray. Dontostoma, Klein.) Inner lip granulated or tuberculated. *N. exuvia*, Linn. (lxxviii, 56).

DEIANIRA, Stolicz. Shell subglobose, consisting of few whorls, the last of which is the largest, often carinated posteriorly; aperture large, semilunar; inner lip thick with three folds, the posterior one of which is the strongest. Operculum broadly oval, calcareous, with a tooth on the inner edge, and a groove corresponding to the strong posterior fold of the inner lip. Cret., fresh and brackish water deposits of the N. Eastern Alps. *N. bicarinata*, Stol. (lxxviii, 57, 58).

LISSOCHILUS, Pethö., 1882. Outer lip sharp, not thickened nor dentate within, inner lip not dentate. Triassic and Jurassic. *N. sigaretina*, Buv.

OTOSTOMA, d'Arch., 1859. (? Lyosoma, White.) Shell thick, globose; upper part of body-whorl with somewhat curved folds and very fine spiral lines; inner lip callously thickened, toothed; outer lip obliquely truncate, not thickened within. *N. rugosa*, Hœningh. Cretaceous.

DESHAYESIA, Raulin, 1844.

Etym.—Dedicated to M. Deshayes, author of "Description des Animaux sans Vertèbres dans le bassin de Paris," etc.

Syn.—Naticella, Grateloup (non Münster). Oncochilus, Pethö., 1882.

Distr.—2 sp. Oligocene and Miocene; Paris and Bordeaux basins. *D. Neritoides*, Grat. (lxxviii, 59).

Shell subglobose, thick, umbilicated; spire short; aperture entire, semicircular, oblique; columella oblique; callosity denticulated; umbilicus covered by the callosity; right lip acute, smooth internally.

This genus presents a very remarkable combination of the characters of Natica and Nerita, and appears to establish a passage between these two genera, types of distinct families.

NERITOPSIS, Grateloup.

Syn.—Radula, Gray. Peltarion, Desl. Cyclidia, Rolle. Delphinulopsis (in part), Laube. Scaphanidia, Müll. (The last three founded on opercula.)

Distr.—1 recent and 20 fossil sp. Triassic—; Europe. *N. radula*, Linn. (lxxviii, 60–62).

Shell subglobular, neritiform, with the spire a little elevated; columellar lip not dentate, largely excavated or sinused in the middle. The fossil opercula of this genus were, until recently, believed to be the beaks of cephalopods (Peltarion).

NERITOMA, Morris.

Distr.—Jurassic; Europe. *N. angulata*, Sowb. (lxxviii, 63).

Shell ventricose, thick; apex eroded; aperture with a notch in the middle of the outer lip; inner lip excavated in the middle, without teeth. Casts of this shell are common, and exhibit the condition of the interior characteristic of all the Nerites; it was probably fresh water.

NERIDOMUS, Morris and Lycett. Shell smooth, ovately globose; spire small, oblique; the last whorl very large; aperture ovate or semilunar; outer lip thick, inner lip thick, convex and smooth. Great Oolite; England. *N. hemisphærica*, Römer (lxxviii, 64).

NERITINA, Lam.

Syn.—Neritella, Humph. Lamprostoma, Swains.

Distr.—140 sp. Tropical and subtropical; West Indies, Europe, India, Philippines, Polynesia, West America. Fossil, 20 sp. Jurassic, Eocene—. *N. communis*, Quoy (lxxviii, 65).

Shell globular, rather thin, aperture-margin thickened; outer lip acute; inner lip straight, denticulated. Operculum shelly with a flexible border; exhibiting two processes which von Martens calls the "rib" and "peg," and in which he has found the characteristics of several groups of minor value. Animal similar to Nerita.

Neritina can only be distinguished from Nerita by slight differences in the operculum and by the general facies.

The Neritinæ are small, smooth globular shells, ornamented with a great variety of black or purple bands and spots, covered

with a polished horny epidermis. They are mostly confined to the fresh waters of warm regions. One species (*N. fluviatilis*) is found in British rivers, and in the brackish water of the Baltic. Another extends its range into the brackish waters of the North American rivers; and the West Indian *N. viridis* and *meleagris* are found in the sea.

Some are amphibious, clinging to the roots of Nipah palms and other trees on the margins of rivers, while a few inhabit the foliage of tall trees that overhang the waters.

NERITINA (restricted), Swainson. Shell globular or oval-conic, usually brilliantly ornamented with colors; inner lip crenulated, rarely simple. Philippines, etc.

THEODOXUS, Montf. (Vitta [Klein], Adams. Puperita, Gray. Elea, Ziegler.) Shell transverse, smooth or nearly so; inner lip flattened, simple-edged or denticulated. Operculum, peg rudimentary. Inhabits the fresh waters of Europe. Kobelt has divided this group into NERITOGLOBUS, for species of the form of *N. fluviatilis* (lxxviii, 66), and NERITICONUS, for the conical forms, like *N. Mertoniana* (lxxviii, 67).

DOSTIA, Gray. (Mitrula, Menke.) Shell sandal-shaped, solid, the apex completely posterior and a little lateral; peristome continuous and free; inner lip septiform, arcuated and denticulated in the centre of its margin. Brackish water, East Indies. *N. crepidularia*. Lam. (lxxviii, 68).

CLYPEOLUM, Recl. (Neritella [Humph.], Adams.) Shell globular, oval or conic; thin, covered by a corneous epidermis; aperture semilunar; inner lip straight, flattened, smooth or denticulated on the margin; outer lip very full, often produced into a tongue upon the spire posteriorly. Operculum, peg and rib well developed, quite separated from each other. Mostly Polynesian. *N. pulligera*, Linn. (lxxviii, 69, 70).

CLITHON, Montfort. (Corona, Recluz.) Shell coronated with tubercles, or short or long spines, covered with a corneous epidermis; inner lip usually denticulated, presenting frequently a large superior tooth. Operculum with peg and rib both well developed, connected in half their length. The spines that usually ornament the whorls are tubular, and sometimes very long; the Clithons inhabit tropical countries; they crawl slowly, and only show during locomotion the tentacles and the tip of the muzzle; they prefer a stony bottom, clear and free from weeds, where the water is tolerably quiet. *N. longispina* (lxxviii, 71).

NERITONA, Martens. Peg of the operculum depressed, almost flat, lobate at its tip. *N. labiosa*, Sowb. (lxxviii, 72). Fresh water, Polynesia. Too close to Clypeolum.

NERITODRYAS, Martens. Rib of the operculum deeply furrowed, multilobate at the tip, and deeply excavated beneath. Living

on damp foliage above the water. Philippines. *N. cornea* and *N. Philippinarum* are members of this group—which is too close to the typical one.

SMARAGDIA, Issel. (Gaillardotia, Bourg.) Eyes sessile, not stalked. *N. viridis*, Linn. (lxxviii, 73).

NERIPTERON, Lesson. Shell flattened, biauriculated posteriorly; spire posterior, lateral; inner lip septiform, its margin denticulated. Polynesian. *N. vespertina*, Recluz (lxxviii, 74).

ALINA, Recluz. Shell flattened, dilated posteriorly, the upper end of the exterior lip prolonged upon the spire, transversely; inner lip finely denticulated. Scarcely different from Neripteron. Polynesia. *N. latissima*, Brod. (lxxviii, 75).

NAVICELLA, Lam.

Etym.—*Navicella*, a small boat.

Syn.—Catillus, Humph. Cibota, Brown.

Distr.—33 sp. India, Mauritius, Moluccas, Australia, Pacific. *N. apiata*, Guillou (lxxviii, 76.) *N. Janelli*, Recl. (lxxviii, 77).

Shell oblong, smooth, limpet-like; with a posterior, submarginal apex; aperture as large as the shell, with a small columellar shelf, and elongated lateral muscular scars. Operculum very small, shelly, with horny margin, with a lateral apophysis (lxxviii, 78).

Head large; foot attached on each side to the visceral mass, forming a cavity open behind. The operculum is applied to the dorsal side of the foot and is concealed in the cavity which it forms with the visceral mass. The species, which are exclusively East Indian and Polynesian, are usually found on the banks of rivers adhering to floating sticks and to the petioles and roots of the Nipah palms and other plants that live near the rivers; they are also found attached to smooth stones.

SEPTARIA, Fer. Apex submarginal. *N. Entrecasteauxii*, Recluz (lxxviii, 79).

ELARA, H. and A. Adams. Apex a little elevated above the posterior margin, laterally recurved. *N. Lapeyrousei*, Recl. (lxxviii, 80).

Dr. Gray has divided the genus from characters derived mostly from the opercula, partly from the shells; like the smaller groups above noted, these are very unsatisfactory.

CATILLUS, Humph. (= Navicella, restricted.) Shell elliptical, mouth wide; inner lip flat, shelving, transverse or slightly regularly arched. Operculum, shelly plate subquadrangular.

ELANA, Gray. Operculum moderate, thin.

LAODIA, Gray. Operculum moderate, as long or longer than broad, thick; upper lobes subequal, obtuse or acute; the right rib indistinct and separated from the margin by a granular space,

which is widest in the middle of the edge; nucleus obscure, punctured.

PARIA, Gray. Shell elliptical, mouth wide; inner lip flat, shelving upwards, produced and truncated in the middle, with a roundish notch on each side near the margin of the cavity. Operculum, shelly plate subquadrangular, lower edge straight, transverse, with a flexible flap, the upper edge with two lobes, the marginal lobe elongate, linear.

STENOPOMA, Gray. Shell elongate; mouth elongate, narrow. Operculum oblong-elongate, the horny part triangular, very oblique, acute near the nucleus, and rounded at the end; shelly plate elongate, thin, with two elongated ridges on the upper end, the marginal one produced into a spine, with a notch on its left margin.

ORTHOPOMA, Gray. Operculum oblong; horny part triangular, rather oblique; shelly plate half oblong, rather narrowed above, and rounded at the upper edge, with a very slight fold diverging from the nucleus to the left upper margin; the anterior cartilaginous flap large, broad. Shell unknown.

The characters of all these divisions so run together through a series of specimens that they may be regarded as practically worthless.

VELATES, Montfort.

Distr.—Tertiary. *V. perversa*, Linn. (lxxviii, 81, 82).

Shell oval-conic, spiral at the apex only; last whorl greatly enlarged, resembling Trochita in shape; aperture basal, semicircular, forming with the wide flat, shelf-like columellar lip a circular outline; columellar lip dentate.

VELATELLA, Meek, 1878. Cretaceous and Laramie; United States. *V. carditoides*, Meek (lxxviii, 85, 86).

PILEOLUS (Cookson), J. Sowerby.

Etym.—*Pileolus*, a little cap.

Distr.—Marine; only known as fossils.

Shell limpet-like above, with a subcentral apex; concave beneath, with a small semilunar aperture, and a columellar disk, surrounded by a broad, continuous peristome.

The secondary species have the basis generally rounded and the apex subcentral, while the tertiary species have it more oval and the apex terminal; to the latter, approaching more nearly the recent Navicellæ, Deshayes applies the subgeneric name TOMOSTOMA. *P. radiatus*, d'Orb. (lxxviii, 83, 84).

FAMILY LIOTIIDÆ.

Shell depressed spiral, white, ribbed, sometimes cancellate, or nodulous; aperture orbicular, rarely pearly within. Operculum corneous inside, outside having a calcareous coat formed of separate, pearl-like, shelly particles placed in spiral lines.

The animal differs from that of Turbo by the absence of lobes between the tentacles, but appendages are present on the outer side of these; median head-lobes are, however, known in Cyclostrema, the animal of which rather resembles that of Scissurella; the body is cylindrical, tentacles either thick and short or thin and prolonged; foot small, with short appendages, head produced, eyes on conspicuously thickened bulgings.

LIOTIA, Gray.

Distr.—Tropical and subtropical. Fossil. Jurassic—. *L. scalaroides*, Reeve (lxxix, 87).

Shell turbinated or depressed, varicose, perforated or umbilicated; whorls ribbed or cancellated; aperture rounded, pearly within; peristome thick, callously margined.

ARENE, H. and A. Adams. Whorls muricated, the last subspinous or angulated; peritreme more or less angular. *L. australis*, Kiener (lxxix, 88).

CYCLOSTREMA, Marryat.

Syn.—Delphinoidea, Brown. Lippistes, Montf.

Distr.—23 sp. Mostly Japan and Philippines; Europe, Australia, West Indies. *C. cancellata*, Marryat (lxxix, 89). Fossil. Tertiary.

Shell orbicular, depressed, widely umbilicated, spire short; whorls transversely striated or cancellated; aperture round, not nacreous; peristome continuous, simple.

Animal. Eye-peduncles very short; tentacles ciliated; foot with long, curved, linear auricles in front, the sides with three ciliated filaments.

CYNISCUS, H. and A. Adams. Umbilicus surrounded by a spiral callosity; whorls ornamented by transverse granose ribs; outer lip rather thick, subcrenulated, prolonged posteriorly upon the penultimate whorl. *C. granulata*, A. Ad.

MÖLLERIA, Jeffreys. Shell remarkably solid, with strong and partly dichotomous transverse ribs; peristome continuous. Operculum calcareous, multispiral. Foot furnished with filaments. *M. costulata*, Möller. Europe.

DARONIA, A. Ad. Shell orbicular, discoidal, evolute, spire depressly concave; whorls rounded, more or less disunited; aperture circular, peritreme continuous. Philippines, Japan. *C. spirula*, A. Ad. (lxxix, 90).

TUBIOLA, A. Ad. Shell subevolute or loosely enrolled; whorls rounded, simple, concentrically striated; aperture subcircular; peritreme continuous, margin acute, entire. Two Japanese and one British species (*Skenea divisa*). *C. nivea*, Chemn. (lxxix, 91).

MICROTHECA, A. Ad. Shell globosely turbinate, widely umbilicate, somewhat porcellanous; radiately, rugosely plicate; sutures channeled: whorls crenulate at the sutures; aperture semicircu-

lar; peritreme continuous, inner lip thickened and arcuate, outer lip with the margin thickened; umbilicus crenulate. Japan. *C. crenellifera*, A. Ad. (lxxix, 92).

MÖRCHIA, A. Ad. Shell obliquely ovate, depressed, widely umbilicated, convex above, flat beneath; whorls rapidly increasing, the last dilated, ascending and embracing the other whorls as far as the apex; aperture oblong, oblique, somewhat horizontal, dilated below, narrowed above; peritreme continuous, thickened. Japan. *C. obvoluta*, A. Ad. (lxxix, 93).

CIRSONELLA, Angas. Shell minute, globosely turbinate, smooth, narrowly umbilicated; aperture circular, peritreme continuous, slightly thickened. *C. australis*, Angas (lxxix, 94).

DISCOPSIS, Folin. Shell discoidal, depressed, umbilicated; margins of the oblique aperture canaliculately joined upon the penultimate whorl. 2 sp. W. Africa.

FAMILY ROTELLIDÆ.

Shell more or less lenticular, polished; umbilical region covered by a large, convex, subvitreous callus. Operculum thin, corneous, ciliated on the outer edge; animal with rudimentary rostrum; frontal lobes greatly developed.

ROTELLA, Lam.

Etym.—Diminutive of *rota*, a wheel.

Syn.—Globulus, Schum. Umbonium, Link.

Distr.—20 sp. India, China, Japan, Philippines, N. Zealand. *R. Zelandica* (lxxix, 95, 96). Fossil. Devonian—.

Shell depressed, lenticular, the spire depressed conical; aperture semiorbicular, outer lip sharp; base with a convex, rounded umbilical callus.

Animal. The lateral fringe of the foot is distinct, with three tentacular filaments on each side; at the front of the right side, near the base of the tentacles, it is produced into an oblong, fleshy lobe. The right tentacle is the larger and free, with an oblong, compressed lobe on its hinder side which has an indistinct indication of an eye; the left tentacle is smaller and partly attached to the upper side of the left eye-pedicel, which is cylindrical, bearing a very distinct eye, and furnished with a large, membranous expansion attached to the whole of its length on its left side, and which is fringed at the edge. This frontal appendage, when the animal is alive, is folded on itself to form a tube, which has caused it to be mistaken for a siphon.

ETHALIA, H. and A. Adams. (Pseudorotella, Fischer.) Whorls convex, smooth or transversely striated; columellar lip terminating anteriorly in a callosity. Scarcely differing from the typical group. *R. Guamense*, Quoy (lxxix, 97).

HAPLOCOCHLIAS, Carpenter. Shell like Collonia, but not pearly;

aperture circular, varicose; columella not callous. Animal and operculum unknown. Its affinities may be with Ethalia. *R. cyclophoreus*, Carp. Cape St. Lucas.

PARKERIA, Gabb. (After C. F. Parker, curator of the Philada. Academy.) Shell minute, in form like Rotella, but with the shell-substance vitreous and transparent or translucent like Vitrinella; inner lip thickened, and the umbilicus covered with a not very heavy callus as in Rotella. Miocene; W. Indies. 1 recent species. *R. vitrea*, Gabb (lxxix, 98).

TURBINA, de Koninck, 1881.

Distr.—4 sp. Carboniferous; Europe. *T. deornatus*, Kon.

Shell top-shaped, thin and fragile, smooth; spire of 5–8 convex whorls; mouth large, transversely rounded, the margin sharp, not thickened, columella not twisted; umbilicus narrow and deep, sometimes wanting.

PLOCOSTYLUS, Gemmellaro, 1878.

Distr.—Liassic, Jurassic; Italy. *P. typus*, Gemm.

Shell top-shaped, thick, smooth; spire obtuse; whorls rapidly enlarging, the last very large, rounded; base more or less flattened; mouth round; inner lip straight, short, ending in an anterior fold, forming a tubercle; outer lip obtuse.

TEINOSTOMA, H. and A. Adams.

Distr.—8 sp. Philippines, Japan, Mazatlan. *T. politum*, A. Ad. (lxxix, 99).

Shell orbicular, depressed, subspiral, polished or spirally striated, last whorl rounded, or angulated at the periphery; umbilical region covered with a large, flat callosity; aperture transverse; inner lip smooth, callous; outer lip thin, simple, not margined or reflected.

CALCEOLINA, A. Ad. Shell neritiform, oblong, depressed; spire small; whorls rapidly increasing, umbilical region callous; aperture semicircular; inner lip with a large wide callus, covering posteriorly the umbilicus; margin of the callus straight, simple. Japan. *T. pusilla*, Ads. (lxxix, 100).

[CYCLORA, Hall.

Distr.—*C. minuta*, Hall. Palæozoic; Ohio.

Subglobose, thin, small, spire short, consisting of a few whorls; columella smooth, slightly reflected over a minute umbilicus; aperture circular. See p. 223.]

ANOMPHALUS, Meek and Worthen.

Distr.—*A. rotulus*, Meek and Worthen (lxxix, 1). Carboniferous; Ills.

Shell depressed, sublenticular, imperforate, smooth, volutions

somewhat embracing above, and each hiding all the preceding ones below; aperture wider than high; peristome not continuous; labrum simple, projecting forward above; labium a little sinuous and slightly spreading in the more or less impressed umbilical region.

PITONELLUS, Montfort.

Syn.—Ptychomphalus, Agassiz. Lewisiella, Stolicz.

Distr.—Lias, Cretaceous; Europe. *P. archiacianus*, d'Orb. (lxxix, 2). *P. conicus*, d'Orb. (lxxix, 3).

Shell depressed or conic, whorls generally rounded, the base with a very strong shining callus; lip simple, sharp.

CROSSOSTOMA, Morris and Lycett.

Distr.—2 sp. Oolite; England. *C. Prattii*, Morris and Lycett (lxxix, 4).

Shell thick, depressed turbinated, without umbilicus; aperture subrotund, entire; outer lip smooth; columella toothed when young, tooth concealed by callus in the adult.

TROCHOPSIS, Gemmellaro, 1878. Shell top-shaped, thick, shining, imperforate; outer lip with four inferior tuberculate spiral ribs; inner lip curved, sharply defined by a furrow. *C. Moroi*, Gemm. Liassic.

PTEROCHEILOS, Moore.

Distr.—*Pt. primus* (lxxix, 5). Liassic; England.

Very thick, small, with the general contour angulated or rhomboidal, smooth, spire short, periphery of last whorl carinated, the carina terminating in a wing-like projection of the outer lip; aperture with a thick, circular peristome, columella thick, folded, subumbilicated, greatly extending beyond the peristome, and possessing a wide but shallow sulcus towards its base.

PLEURATELLA, Moore, 1867.

Distr.—*P. prima*, Moore. Lias; Europe.

Shell small, thick, smooth; spire much depressed; whorls 4–5, rapidly enlarging; last whorl very large, rounded; aperture round or oval; inner lip straight, with thick lengthened columella, having an umbilicus-like groove.

FAMILY PHASIANELLIDÆ.

Shell bulimiform, smooth, polished, richly ornamented with bright colors, without epidermis. Operculum oval, calcareous.

Animal with long ciliated tentacles; head-lobes pectinated, wanting in the minute species; neck-lobes fringed; sides ornamented with three cirri; branchial plume long, partly free; foot rounded in front, pointed behind.

Distinguished from the Turbinidæ by the form of the shell,

from the elongated species of Trochidæ by the calcareous operculum.

PHASIANELLA, Lam.

Pheasant-shell.

Distr.—25 sp. Australia, large species; India, Philippines, small species; Mediterranean, Britain, West Indies, very small species. Fossil, 70 sp. Devonian—; Europe. *P. bulimoides*, Lam. (lxxix, 6).

Shell elongated, polished, richly colored; whorls convex; aperture oval, not pearly; inner lip callous, outer thin. Operculum shelly, callous outside, subspiral inside.

When the animals of this genus crawl, the foot appears to be divided longitudinally into halves, which advance alternately; when the right side moves, the left remains stationary, and when this in turn is carried forward, the other half remains as a point of support; it may be compared to the amble or canter of a horse. In Phasianella proper, the tentacles are ciliated, the head-lobes fringed, and the sides of the foot furnished with three cirri. In the smaller species, forming the Tricolia of Risso, the head-lobes appear to be wanting. The larger species, all of which have beautifully variegated shells, are principally from Australia, and the smaller ones from the Mediterranean, West Indies and South Africa.

TRICOLIA, Risso. (Eudora, Leach.) Shell thin, spire elevated, apex mammillated; suture profound; aperture oval. Small species, Mediterranean, etc. *P. Niciensis*, Risso (lxxix, 7). *P. pulla*, Linn. (lxxix, 8).

LEIOPYRGA, A. Ad. Shell turbinate, thin, smooth, polished; aperture semicircular, shorter than the spire, inner lip thin, columella incurved, excavated. *P. picturata*, A. Ad.

EUCOSMIA, Carp. Shell small, turbinate, solid, smooth, variegated, not nacreous; aperture with the margins nearly continuous, but not callous; columella slightly excavated; axis umbilicated. 6 sp. West Coast of N. America. *P. variegata*, Carp.

ALCYNA, A. Adams.

Distr.—2 sp. Japan. *A. rubra*, Pease.

Shell acuminately ovate, imperforate, spire short, conical, acute; whorls flat, smooth; aperture oval; inner lip callous, terminating in a strong tooth below; outer lip acute, smooth within.

CHROMOTIS, A. Ad.

Distr.—*Phas. neritina*, Dunker (lxxix, 9). Cape of Good Hope.

Shell ear-shaped, thin, polished; spire very short; whorls few, rapidly enlarging; aperture oval, columella flattened and solid. Operculum calcareous.

Family TURBINIDÆ.

Shell spiral, turbinated, nacreous inside. Operculum calcareous, paucispiral.

Animal. Tongue elongate, median teeth broad, laterals five, denticulated, uncini very numerous, slender, with hooked points (xii, 47). Head proboscidiform; tentacles subulate, sometimes ciliated; eyes on free peduncles at their outer bases; two more or less developed head-lobes between the tentacles. Gill single, long and linear. Sides of the foot with a large neck-lappet near the eye-peduncle, continuous with a conspicuous side-membrane, bearing on its free margin from three to five tapering filaments; operculigerous lobe often ornamented with cirri. Littoral and herbivorous, characterized by the fringed lobes and tentacular cirri of the head and sides, their pedunculated eyes, and by the pearly nature of their shells beneath the epidermis and outer layer. They are invariably marine, feeding on the sea-weeds which abound along the shore, and are distributed in all parts of the globe, being most numerous and of larger growth and more beautiful colors in tropical seas.

The Turbinidæ are distinguished from the Trochidæ generally by the form of the shell, and by the operculum, which is calcareous and paucispiral in the former, corneous and multispiral in the latter. The arrangement of the groups of both families corresponds with that proposed by Dr. Paul Fischer in his excellent monographies of Trochus and Turbo.

Turbo, Linn.

Top-shell. *Etym.*—*Turbo*, a whipping top.

Distr.—76 recent sp. World-wide in tropical seas. Fossil, 400 sp. L. Silurian—; universally distributed. *T. marmoratus*, Linn. (lxxix, 10).

Shell turbinated, solid; whorls convex, smooth or often grooved or tuberculated; aperture large, rounded, slightly produced in front. Operculum shelly and solid, callous outside, and smooth, or variously grooved and mammillated, internally horny and paucispiral. In *T. sarmaticus* the exterior of the operculum is botryoidal, like some of the tufaceous deposits of petrifying wells.

TURBO (restricted). Shell smooth, or tuberculate, covered by a smooth epidermis; inner lip flattened, more or less produced in front; no umbilicus. Operculum spiral on its inner face, convex and smooth or granular (not ridged) externally. 17 sp. Indian and Pacific Oceans, W. Indies.

The "green snail" of the dealers, the *Turbo marmoratus*, is very largely used for ornamental purposes. Slices of this shell ground down to a thin surface, are employed for covering or inlaying various articles, such as small stamp-cases, fancy boxes,

etc., as well as for buttons, earrings, buckles, etc. The light-greenish iridescent play of color of this shell is more ornamental than that of the ordinary white mother-of-pearl. Fine large shells of this species formed the drinking goblets of the Scandinavian monarchs, and are often still met with, very elegantly mounted and set with jewels. The Turk's cap (*T. sarmaticus*) is less extensively used for similar purposes.—SIMMONDS, *Commercial Products of the Sea*, 293.

SARMATICUS, Gray. (Cidaris, Swains.) Shell nodulous. Differs from Turbo principally in having a black layer between the outer opaque and inner pearly layers of the shell; it forms a dark zone between the edges of the two coats just within the aperture, and is frequently exposed on the upper part of the columella by absorption of the outer layer. Australia, New Zealand.

SENECTUS, Humph. Shell solid, with revolving, squamose or spinose ridges covering the whorls; axis usually narrowly perforated; aperture usually slightly produced in front, with sometimes a short channel. 25 sp. Indian and Pacific O., West Indies. *T. margaritaceus*, Reeve (lxxix, 11).

OCANA, Adams. Shell turbinate, solid, smooth; axis imperforate; spire short, conical; aperture subcircular, wider than long; inner lip flattened, excavated, scarcely produced anteriorly, with an extended thin callus. Operculum with a convex, granular spiral rib, axis deeply perforated, outer edge simple. *T. cidaris*, Gmelin (lxxx, 19). Cape of Good Hope.

MARMOROSTOMA, Swains. (Lunella, Bolt.) Shell thick, smooth or tuberculate; aperture produced in front; columellar callus covering the axis, which is umbilicated, however; the umbilicus often at the upper end of a curved channel in the callus. Operculum spiral, with central nucleus, and an indistinct, subcentral, external rib. 5 sp. Ind. and Pacific Oceans. *T. coronatus*, Gmel. (lxxx, 20, 21).

MODELIA, Gray. Shell rather thin, granular. Operculum granulous externally, with a semicircular ridge on the edge. Australia, N. Zealand. *T. rubicundus*, Reeve (lxxx, 27).

AMYXA, Troschel. (Prisogaster, Mörch.) Shell solid, turbinated with elevated spire; whorls with revolving riblets; aperture rounded; inner lip sillonated; outer lip black-bordered and subcrenulated within. Operculum as in Modelia. The animal of this subgenus, figured by d'Orbigny, appears to be furnished with a single, elongated, posterior filament, numerous shorter, anterior, tentacular filaments on the lateral membrane of the foot, and two conspicuous cirri on the sides of the opercular lobe. 2 sp. West Coast of tropical America. *T. niger*, Gray (lxxx, 28).

CALLOPOMA, Gray. Shell turbinated-elevated, not umbilicated; whorls angulated or nodulous; aperture rounded, produced in front; inner lip wide, sillonated. Operculum with a spiral central

rib, and several smaller marginal ribs. 4 sp. W. Coast of America, China, Japan. *T. fluctuatus*, Gray (lxxx, 29).

NINELLA, Gray. Shell turbinated, depressed, rugose, tuberculated, umbilicated; internal lip wide, concave, with a longitudinal nacreous excavation near the columella. Operculum with two parallel spiral ribs. Australia, New Zealand. *T. torquatus*, Gmel. (lxxx, 22).

COLLONIA, Gray. Shell small, thick, turbinated, with revolving ribs or smooth, not umbilicated. Operculum with gradually enlarging whorls, a convex external rib and a central pit. Recent and tertiary. *T. sanguineus*, Linn. (lxxix, 12).

ANADEMA, H. and A. Adams. Shell conoidal-depressed, whorls with revolving series of granules; umbilicus with a spiral callus, which enlarges and joins the outer lip; columella terminating anteriorly in one or two tubercles. *T. MacAndrewi*, Mörch (lxxix, 13).

The following genera, recently described by de Koninck, might be referred, with perhaps equal propriety, to other groups.

TURBONILLINA, de Koninck, 1881.

Distr.—Devonian, Carb.; Europe. *T. lepidus*, de Kon.

Shell small, depressed orbicular; umbilicus funnel-like; spire short; whorls convex, finely spirally ribbed; mouth oval, inner lip not thickened.

PORTLOCKIA, de Koninck, 1881.

Distr.—10 sp. Devon. to Carb.; Eur. *P. parallela*, Phil.

Turbiniform, imperforate; spire somewhat elevated; whorls convex, with fine spiral ribs, some becoming stronger on the last whorl; mouth oval, inner lip arched, not thickened.

ACCLISINA, de Koninck, 1881.

Syn.—Turbonilla, Geinitz.

Distr.—*A.* (*Murchisonia*) *striatula*, Kon. Carb.

Small, lengthened-conical, imperforate; whorls convex, spirally striate; mouth oval, outer lip sharp, columella slightly thickened, not arched.

? PITHODEA, de Koninck, 1881.

Distr.—2 sp. Carb.; Belgium.

Shell large, thin, ovate, imperforate; whorls rapidly increasing, somewhat dissimilarly, spirally ribbed, with a median smooth, transversely striated band; mouth large, ovate.

TURBONILOPSIS, de Koninck, 1881.

Distr.—2 sp. Carb.; Europe.

Small, depressed, smooth, umbilicated; umbilicus surrounded by a callous thickening.

TURBONITELLA, de Koninck, 1881.

Distr.—Devon. to Carb.; Europe. *T. biserialis*, de Kon.

Shell turbiniform, with convex, smooth or nodulous whorls; mouth round or oval, inner lip callously thickened, outer lip sharp, thin; a narrow umbilical slit.

RHABDOPLEURA, de Koninck.

Distr.—*Monodonta solida*, Kon. Carb.

Conical, height and diameter about equal; whorls 4–5, slightly convex, rapidly enlarging, the last more than half the total length, striate, and finely spirally ribbed; aperture transversely rounded; inner lip somewhat callous, curved and thickened below.

ONKOSPIRA, Zittel.

Distr.—*O. ranellatus*, Quenst. Coral Rag.

Shell thin, lengthened-trochiform, spire pointed; whorls convex, spirally ribbed, keeled or clathrate with one or two varices, which are continuous, as in Ranella; mouth rounded-ovate; columella forming an angle with the thickened outer lip.

HAMUSINA, Gemmellaro.

Distr.—Lias; Europe. *H. Bertheloti*, d'Orb.

Shell thin, conical-turreted, sinistral, tuberculate, imperforate; spire sharp; body-whorl angular; aperture rounded, inner lip callous.

PLATYACRA, v. Ammon, 1882.

Distr.—Rhætian; Bavaria. *P. impressa*, Schafh.

Shell thin, turreted, sinistral, widely and deeply umbilicate; whorls with a nodulous keel; apex flattened.

IMPERATOR, Montfort.

Syn.—Astralium, Link. Tubicanthus, Swn. Canthorbis, Swn. Hercoles, Montf.

Distr.—50 sp. East and West Indies, W. America, Australia. Fossil. Trias—.

Shell trochiform, depressed conic; whorls rugose or spinous, the latter especially at the sharply angulated periphery of the last whorl; aperture subquadrangular, subtruncated in front. Operculum calcareous.

IMPERATOR (restricted). Umbilicated. Operculum with a subcentral tubercle and a spiral submarginal rib. *I. longispina*, Lam. (lxxx, 23, 24).

CALCAR, Mont. (Stella, Klein. Cyclocantha, Swains. Astrea, Bolt. Turboidea, Seeley.) Not umbilicated; spire more elevated. Operculum externally subspiral, and with a central pit. W. Indies, Indian Ocean. *I. stellaris*, Gmel. (lxxx, 25).

GUILFORDIA, Gray. Periphery with long spines; whorls granose,

subumbilicated, the umbilical region callous. Operculum flattened, with a depressed marginal line. East Indies. *I. triumphans*, Phil. (lxxx, 26).

UVANILLA, Gray. Shell trochiform, conical, with moderately elevated spire; base concave, not umbilicated; whorls flattened, rugose, spinously fringed. Operculum with two convex ribs, one nearly parallel to the margin, the other arcuated, subcentral. 5 sp. Australian seas. *I. fimbriata*, Lam. (lxxx, 30).

PACHYPOMA, Gray. Like Uvanilla, but base of the shell more concave. Operculum oval, subquadrangular, externally convex. 7 sp. West Indies, Brazil. *I. cælata*, Chemn. (lxxx, 31).

LITHOPOMA, Gray. Shell turbinated, not umbilicated, spire moderate, whorls with oblique longitudinal ribs and nodules; inner lip concave, subtruncated in front, and with a longitudinal shallow channel. Operculum oval, thick, granulous externally, and flattened at the margins. West Indies. *I. tuber*, Linn. (lxxx, 32.)

POMAULAX, Gray. Shell trochiform, elevated conic, angulated and nodose at the periphery, obliquely ribbed, not umbilicated; inner lip arcuated, with a wide callus, which is channeled, anteriorly truncated. Operculum with three radiating ribs and perforated axis. 7 sp. North Pacific, America and Japan. *I. undosa*, Wood (lxxx, 33).

COOKIA, Lesson. Shell turbinated, not umbilicated; whorls nodulous; columellar lip with a wide flattened callus and spiral shallow excavation. Operculum oval, flat, smooth, with a large subspiral, submarginal rib. New Zealand. *I. Cookii*, Chemn. (lxxx, 34).

BOLMA, Risso. (Tubicanthus, Swn.) Shell turbinated, not umbilicated, rugose or tuberculated, with deep suture; aperture round; inner lip wide, callous, concave. Operculum with a subcentral tubercle and spiral rib. 3 sp. Mediterranean Sea, China, Japan. *I. rugosa*, Linn. (lxxx, 35).

FAMILY TROCHIDÆ.

Shell usually conical, with flattened base, nacreous inside. Operculum corneous, multispiral.

Animal like that of Turbinidæ (p. 304). Differs from that family in its conical shell (usually) and its operculum; that of Turbinidæ being calcareous and paucispiral. Dentition (xii, 46).

DELPHINULA, Lam.

Etym.—Diminutive of *Delphinus*, a dolphin.

Syn.—Angaria, Bolten.

Distr.—20 sp. Eastern tropical seas. *D. melacantha* (lxxx, 36). Fossil. Jurassic—.

Shell orbicular, depressed; whorls few, angulated, rugose, or

spiny; aperture round, pearly; peristome continuous; umbilicus open. Operculum horny, many-whorled. On reefs at low-water.

Animal without head-lobes; sides lobed and cirrated.

ANGARINA, Bayle. (Delphinulopsis, Wright.) Shell sinistral, discoidal, umbilicate, spirally ridged, last whorl crowned with spines; aperture rounded, nacreous within, columellar margin not nacreous. *D. Lesourdi*, Wright (lxxx, 37).

CIRRUS, Sowb. (In part, not Orb. Scævola, Gemm.) Shell sinistral, conical, widely and deeply umbilicated; spire conical, sharp; whorls crossed by longitudinal, nodulous ribs. Liassic. *D. nodosa*, Sowb. England. Sowerby's genus Cirrus contained, besides the above, a Euomphalus and a Pleurotomaria.

LAXISPIRA, Gabb.

Distr.—*L. lumbricalis*, Gabb (lxxix, 14). Cretaceous; New Jersey.

Shell spiral, dextral, partially unwound and the whorls not in contact; aperture simple, lips thin.

This group is perhaps more nearly related to Vermetidæ. At first sight it appears not unlike *Delphinula laxa*, Say, but the latter is a fossil (Caprotinid) bivalve.

[TROCHONEMA, Salter, 1859.

Syn.—Trochonemopsis, Meek.

Distr.—*T. tricarinata*, Meek (lxxx, 38). Devon.; Ohio.

Has been proposed for a Delphinula-like shell with wide umbilicus; it occurs in the palæozoic formations of Europe and North America, and, as in so many other ancient groups, embraces a number of widely different forms. Professor Meek (MSS.) was disposed to place the genus near Delphinula.]

TROCHUS, Linn.

Etmy.—*Trochus*, a hoop.

Distr.—250 sp. World-wide. Low-water to 15 fathoms; the smaller species range nearly to 100 fathoms.

Fossil, 360 sp. Devonian—; Europe, North America, Chili.

Shell pyramidal, with nearly a flat base; whorls numerous, flat, variously striated; aperture oblique, rhombic, pearly inside; columella twisted, slightly truncated; outer lip thin. Operculum horny, multispiral.

Animal with two small or obsolete head-lobes between the tentacles; neck-lappets large; sides ornamented with lobes, and 3–5 cirri; gill very long, linear; lingual teeth 11, denticulated; uncini 90, diminishing outwards.

TROCHUS (restricted). Umbilical region excavated, but not perforated; columella spirally twisted above, terminating in a

point anteriorly. 2 sp. Indo-Pacific. *T. Niloticus*, Linn. (lxxx, 39).

ROCHIA, Gray. Shell with a strong fold on the pillar-lip, and a deep sinus behind, near the whorl. *T. acutangulus*, Chemn. Philippines, Australia.

CARDINALIA, Gray. Conical, whorls flattened, granulated, the the last angular, not umbilicated; columella simple above, a little twisted, and terminating in a point below; outer lip slightly toothed basally. *T. virgatus*, Gmel. (lxxxi, 40). Indian Ocean, Philippines.

TECTUS, Montfort. (Pyramis, Schum., 1817. Pyramidea, Swains.) Shell conical, not umbilicated; whorls smooth or tuberculated, the last angular; aperture wider than long; columella short, spirally twisted, terminating in a point anteriorly. 9 sp. Red Sea, Indo-Pacific. *T. triserialis*, Lam. (lxxxi, 41).

POLYDONTA, Schum., 1817. (Lamprostoma, Swains.) Shell conical, not umbilicated; whorls mostly granular, the last angulated; aperture subrhomboidal; columella spirally twisted, rib-like and plicate, forming a false umbilicus; base of aperture rib-like and dentated, joining the columellar dentitions. 17 sp. Indo-Pacific, Polynesia. *T. maculatus*, Linn. (lxxxi, 42).

PRÆCIA, Gray. Shell with the pillar-lip twisted, simple; axial cavity deep, narrow, with a distinct, narrow, central, spiral rib. *T. elegantulus*, Wood, is the only species.

ANTHORA, Gray. Shell with the pillar-lip twisted, simple; axial cavity moderate, narrow, with several opaque, subspiral ridges. *T. viridis*, Gmel.

BELANGERIA, Fisher. No diagnosis published. *T. scabrosus*, Phil. (lxxix, 15). Indian Ocean.

INFUNDIBULUM, Montfort. (Carinidea, Swains.) Shell conical; whorls flattened, the last angular, base concave; columella without teeth or with the teeth obsolete. 6 sp. Indo-Pacific, Red Sea. *T. concavus*, Linn.

OMPHALIUS, Phil. Shell convex-trochiform, umbilicated; whorls with revolving series of granules, the last whorl bluntly angulated at the periphery; umbilicus encircled by a callosity; columellar lip terminated by a tooth anteriorly, below which are small tubercles; outer lip usually internally grooved. 11 sp. East and West tropical America, West Indies. *T. viridulus*, Gmel.

ISANDRA, H. and A. Adams. (Eudora, Ad.) Shell polished, subconoidal, whorls rounded; aperture subquadrangular; inner lip straight, dentate below, forming an angle at its basal union with the outer lip; umbilicus open, profound, surrounded with crenulations. Australia and Philippines. *T. coronatus*, A. Ad. (lxxix, 16).

LIVONA, Gray. (Cittarium, Phil. Meleagris, Montf.) Shell

turbiniform, solid, smooth, umbilicated; umbilical region strongly callous; aperture rounded, outer lip thin. Animal: lateral membrane of the foot with numerous compound appendages. W. Indies. *T. pica*, Linn. (lxxxi, 47).

TEGULA, Lesson. Shell conical, spire pointed, with revolving granulated ribs; columella spirally twisted, terminating anteriorly in a large obtuse tubercle. 2 sp. W. tropical America. *T. pellis-serpentis*, Wood (lxxxi, 43).

CHLOROSTOMA, Swains. Shell conoidal, profoundly umbilicated, or umbilical region covered by a callosity; whorls smooth or subcarinated, the last subangulated at the base; columellar lip spirally twisted around the umbilicus; outer lip angulated at the base and sometimes presenting one or two tubercles. 16 sp. W. North America, Japan, China. *T. argyrostomus*, Chemn. (lxxxi, 44).

CŒLOTROCHUS, Fischer. Uncharacterized. *T. tiaratus*, Quoy. New Zealand.

EURYTROCHUS, Fischer, 1880. Uncharacterized. 4 sp. Australia, N. Caledonia. *T. Lehmanni*, Menke.

MINOLIA, A. Adams. (*Etym.—Mino-Sina*, a Japanese island.) Shell globosely conoidal, widely and profoundly umbilicated; whorls rounded, clathrate, suture canaliculate; last whorl subsolute towards the aperture; umbilicus perspective; aperture circular, pearly within; peristome continuous, thin, acute. *Distr.*—5 sp. Australia, New Caledonia, Japan. *T. dianthus*, Fischer (lxxxi, 45).

MONILEA, Swains. (Talopia, Gray.) Shell orbicular, depressed, widely umbilicated; whorls encircled by grooves, the last rounded; umbilicus encircled by a striated callus; columella terminating anteriorly in one or two tubercles. 5 sp. Pacific, Australia, New Caledonia. *T. calyculus*, Wood.

LEIOTROCHUS, Conrad. Polished, entire, without umbilicus; base of columella with two denticles. 4 sp. Miocene; U. S. *T. distans*, Conr. Described as a subgenus of Monilea.

SOLANDERIA, Fischer. Uncharacterized. New Caledonia. *T. nucleus*, Phil.

GIBBULA, Risso. (Phorcus, Risso. Steromphala, Leach.) Shell conoidal, umbilicated; umbilicus cylindrical or infundibuliform; whorls frequently tuberculated above and with channeled suture; columella sometimes terminating in a tubercular tooth. 26 sp. Tropical, world-wide. *T. magus*, Linn. (lxxxi, 46).

KORENIA, Friele. Separated from Gibbula on account of slightly different lingual dentition. European.

PRIOTROCHUS, Fischer. (Aphanotrochus, Martens.) Shell like Gibbula, but pillar-lip denticulated. 2 sp. Indian Ocean. *T. obscurus*, Wood (lxxxi, 50).

FORSKALIA, H. and A. Adams. Shell babylonic with elevated

spire and deep sutures; whorls angulated at the periphery, where they are sulcated. 4 sp. Red Sea. *T. fanulum*, Gmel. (lxxxi, 81).

LEPTOTHYRA, Carp. (Leptonyx, Carp. and Ads. Homalopoma. Carp.) Shell small, turbinated, thick, not umbilicated; aperture circular, slightly angulated anteriorly. The type of this group is the California shell identified as conspecific with the Mediterranean species *Turbo sanguineus*, Linn.; the latter, however, has a calcareous operculum, and is therefore a true Turbo, whilst the operculum of this is corneous, multispiral.

CALLIOTROCHUS, Fischer. Uncharacterized. *T. phasianellus*, Desh.

ZIZYPHINUS, Gray. (Calliostoma, Swains. Conulus, Nardo.) Shell trochiform, conical, not umbilicated; last whorl angulated and usually ribbed at the periphery; aperture quadrangular; columella simple, oblique, often ending in a tooth in front. 28 sp. Universally distributed. *T. zizyphinus*, Linn. (lxxxi, 48, 49).

EUTROCHUS, Ad. Zizyphinus-like shells, but umbilicated, the umbilicus encircled by a carina. 3 sp. West Indies, Indian Ocean, Australia. *T. (Eutrochus) jujubinus*, Linn. (lxxxi, 82).

TURCICA, H. and A. Adams. Shell conoidal, thin, subdiaphanous, imperforate, ornamented with revolving granulated ribs; subangulated at the periphery; suture channeled; columella tortuous, pointed in front, in the middle spreading into a lamina, with one or two teeth on its edge. *T. moniliferus*, Ads. (lxxxi, 51).

TROCHODON, Seeley, 1861. Resembling Zizyphinus, thin, having on the columella two prominent teeth. — Turcica (?). *T. cancellatus*. Cambridge Greensand.

PTYCHOSTYLUS, Gabb. According to the characteristics given by Gabb, apparently does not differ essentially from Turcica. The columella is solid, with two oblique folds. *P. caffea*, from California, is quoted as the type.

LISCHKEIA, Fischer. Uncharacterized. *T. moniliferus*, Lam. Japan.

ODONTOTROCHUS, Fischer. Uncharacterized. *T. chlorostomus*, Menke. Australia.

THALOTIA, Gray. Shell ovate-turriculated, rather thick, not umbilicated; whorls flattened, with revolving ribs, which are sometimes granulated; aperture subrotund; columella tuberculate, truncate in front; outer lip rather thick, crenulated within. 8 sp. Australia, Indian Ocean. *T. conicus*, Gray (lxxxi, 52).

ELENCHUS, Humphrey. Shell elevated conoidal, not umbilicated, spire sharp; whorls rather flat, smooth, polished, usually with distant revolving incised lines; aperture suboval; columella with a tooth-like projection in the middle; outer lip thickened within. 6 sp. Australia. Brilliantly colored shells,

like Phasianella, but very pearly inside. *T. lineatus*, Lam. (lxxxi, 53).

LESPERONIA, Tournouer. Shell pearly, imperforate, elongate-conical, whorls in the type carinated; aperture entire, oblique, pyriform; peristome continuous, margined; columellar margin anteriorly expanded. Operculum (?). *Distr.*—Fossil. Oligicene; Dax. *T. princeps*, Tourn. (lxxxi, 54).

CANTHARIDUS, Montfort. (Cantharis, Fer. Cantharidium, Montf.) Shell ovate, thin; outer lip acute; the columella wants the conspicuous tooth seen in Elenchus; the whorls are encircled by striæ and not polished; interior highly iridescent. 6 sp. Australia. *T. iris*, Chemn. (lxxxi, 55).

FLEMINGIA, de Koninck, 1881. (Trochella, M'Coy.) Shell thin, extended-conical, pointed; whorls numerous, striate or smooth, periphery usually angular; columella thin, slightly extended, forming a point below. Sil. to Carb. *F. Hisingerianus*, de Kon.

BANKIVIA, Beck. Shell subulate, with sharp spire, polished, bright-colored; whorls smooth, flattened, without epidermis; aperture subovate, rather large, not nacreous within; columella twisted, truncated in front; outer lip simple, sharp. Australasia. *T. varians*, Beck (lxxxi, 56).

TROCHOCOCHLEA, Klein. (Osilinus, Phil. Labio, Gray. Melagraphia, Stentz.) Shell elevated, turbiniform, whorls bluntly angled at the periphery, or with revolving carinæ; outer lip thin, smooth within; inner lip spreading, twisted, dentate below; no umbilicus. 10 sp. Europe, W. Africa, Australia. *T. multicarinatus* (lxxxi, 57).

GAZA, Watson. Shell trochiform, pearly; margin of aperture callously reflected; columella mucronately angulated in front; umbilicus with nacreous callus. Operculum corneous, multispiral. *Distr.*—*T. dædala*, Watson. Fiji Is. 610 fathoms. Related in general form to Trochocochlea, but strongly distinguished by its reflected lip.

CALLOGAZA, Dall. Resembling Gaza, but the umbilical callus is only partly reflected over the umbilicus, the pillar is straight, not mucronate, and the nacreous layer is overlaid by a thin, porcellanous layer and a delicate epidermis. 2 sp. West Indies. *T. superba*, Dall.

MICROGAZA, Dall. Shell flattened, rotelliform, resembling a Gaza without reflected lip or umbilical callus, brilliantly nacreous when fresh, and having a distinctly scalariform umbilicus. West Indies. *T. rotella*, Dall.

MONODONTA, Lam. (Labio, Phil.) Shell oval or conoidal, not umbilicated; aperture rounded, angulated behind; columella arcuated, truncated at the base, and terminating in a tooth with channeled side; whorls with revolving riblets, which are usually

tuberculate; outer lip thickened and denticulated within. 6 sp. Indo-Pacific. *T. australis*, Lam. (lxxxi, 58).

CRASPEDOTUS, Phil. (Otavia, Gray. Olivia, Cantraine. Danilia, Brusina.) Shell subconoidal, not umbilicated; whorls convex, tuberculated in spiral series or cancellated; columella twisted, forming a false umbilicus and presenting a strong tooth entering the aperture; outer lip sillonated within, and having an external varix. 2 sp. Mediterranean, N. Caledonia.

EUCHELUS, Phil. (Aradasia, Gray.) Shell conoidal, turbinate, umbilicated; whorls rounded with granulated revolving ribs; columella lamellarly produced into a central tooth; outer lip thickened and crenulated within. Opercular whorls rather few, rapidly increasing. 11 sp. Indo-Pacific. *T. canaliculatus* (lxxxi, 59).

HUTTONIA, Kirk, 1882. Shell turbinated, subglobose; perforate or imperforate; columella with a deep notch at the anterior end; outer lip thickened and crenated internally. *Distr.*—3 sp. New Zealand. *T. bella*, Kirk. Distinguished from Euchelus by having a deep notch instead of a small tooth on the front of the columella.

PERRINIA, H. and A. Adams. Shell trochiform, with flattened, cancellated whorls; aperture subquadrangular; columella nearly straight, with a few posterior tubercles; outer lip subcrenulated within. *P. angulifera*, Adams.

CLANCULUS, Montfort. Shell conoidal or turbinated, not umbilicated; whorls mostly granulous; aperture contracted; columella spirally twisted, forming a false umbilicus, plicated throughout and terminating in a multidentate varix; outer lip dentated within, with sometimes a larger superior tooth. 32 sp. Indo-Pacific, Mediterranean. *T. puniceus*, Phil. (lxxxi, 60).

CAMITIA, Gray. Shell depressed, polished, not umbilicated; whorls rounded; aperture transverse; columella much twisted and produced anteriorly into a lamella, ending in a tooth; outer lip smooth within. *T. vitellinus*, Gould (lxxxi, 61).

LEUCORHYNCHIA, Crosse. Shell perforated, polished, few-whorled; aperture rounded, not pearly; basal margin callously produced across the base of the shell beyond the umbilicus, but without closing it. *T. Caledonica*, Crosse (lxxxi, 71).

OXYSTELE, Philippi. Shell depressed conoidal, smooth, not umbilicated; umbilical region covered by a shining callous expansion of the columella; columella flattened, curved anteriorly to join the outer lip. 5 sp. Australian seas. *T. merula*, Chemn. (lxxxi, 62).

ATAPHRUS, Gabb. Shell form of Oxystele, but the columellar lip anteriorly grooved, the groove terminating in a tubercle above. Cretaceous; North Carolina, California. *T. Kerri*, Gabb (lxxxi, 63).

TROCHISCUS, Sowb. (Norrisia, Bayle.) Shell thick, conoidal, orbicular, covered by an epidermis, smooth; widely umbilicated, umbilicus surrounded by the callous extension of the columella; outer lip not thickened or sculptured within. Operculum with the edges of the whorls elevated, scaly. *T. Norrisii*, Sowb. (lxxxi, 64). West Coast of North America.

DILOMA, Philippi. Shell conoidal, smooth, not umbilicated; whorls rather few, convex; aperture subrotund; columellar lip excavated in the middle and expanded over the umbilical region, produced laterally to join the outer lip; outer lip thin, unarmed. 12 sp. Pacific. *T. Æthiops*, Gmel.

PHOTINULA, H. and A. Adams. Shell orbicular, heliciform, subdepressed, not umbilicated; spire acute; whorls with revolving lines, smooth, polished; umbilical region covered by callus; columellar lip thick, outer lip not thickened, smooth within. 2 sp. South Seas. *T. tæniata*, Wood (lxxxi, 65).

CHRYSOSTOMA, Swainson. Shell very thick, globular-turbinated, polished; spire small, body-whorl large, rounded; margin of aperture thick, especially on the columella; umbilicus covered by a callosity. 1 sp. Indo-Pacific. *T. Nicobaricus* (lxxxi, 66).

LIOTROCHUS, Fischer. Not characterized. *T. callosus*, Koch.

MARGARITA, Leach.

Distr.—20 sp. Boreal, under stones and sea-weed near low-water. *M. helicina*, Fabr. (lxxxi, 67).

Shell thin, globular-conical, umbilicated; whorls rounded, smooth; aperture rounded, pearly; lip sharp, smooth.

BEMBIX, Watson. Shell elevated, conical, carinate, base inflated, umbilicated, thin, pearly, epidermis thin, membranaceous. *M. æola*, Watson. Japan.

MACHÆROPLAX, Friele. Shell more or less conoidal, distinctly umbilicated, unicolored, variously sculptured; aperture subangulated, peristome interrupted. Operculum corneous. *M. striata*, Leach (lxxxi, 68).

SOLARIELLA, S. Wood. With large crenated umbilicus. Fossil, Crag of England; recent, one California species. *M. peramabilis*, Carp.

MARGARITELLA, Meek and Hayden. Shell subdiscoidal or nearly lenticular, thin; nacre of interior bright; umbilicus large, deep, and entirely without crenate margins; volutions narrow, very much depressed, the last one sharply angular around the periphery, and obtusely subangular around the umbilicus; aperture transversely rhombic; lip thin and simple; surface cancellately striated in the typical species. Cretaceous; United States. *M. flexistriata*, Evans and Shumard (lxxxi, 69, 70).

ENIDA, Adams, 1860. Whorls ornamented with spiral and squamous striæ, sutures canaliculated, last whorl carinated at

the periphery; inner lip somewhat expanded, and in the middle reflexed; umbilical margin crenulated. The group is founded upon three species from Japan; cretaceous and tertiary species occur. It is doubtfully distinct from Solariella. *M. Japonica*, A. Ad.

UMBONELLA, A. Ad. Shell globosely conoidal, solid, porcellanous, polished, narrowly umbilicated; aperture subquadrate, the margin simple, a little dilated in front; umbilicus narrow, margin crenulately rugose. *M. murrea*, Reeve. Japan.

VITRINELLA, C. B. Ad.

Distr.—18 sp. W. Coast Centr. Am., West Indies. *V. anomala*, d'Orb. (lxxxi, 72).

Shell minute, depressed turbiniform, widely umbilicated; aperture large, rounded.

VALVATELLA, Gray. Shell conic; whorls rounded, with laminated periostraca; axis imperforate; aperture circular, peristome simple. *V. Grœnlandica*, Gray.

BATHYMOPHILA, Dall. When young umbilicated like Margarita, but the nearly adult has a broad, flattened, minutely granulated pillar, with a polished small tubercle at its end; the adult has this tubercle enlarged, forming a blunt tooth, with granulated surface. *M. euspira*, Dall. W. Indies.

? CLISOSPIRA, Billings, 1865.

Distr.—*C. curiosa*, Billings. Silur.; Canada.

Trochiform, surface reticulated; aperture widely expanded all round in a plane which is at a right-angle (or nearly so) to the longitudinal axis of the spire, the latter conical. The cavity occupied by the animal appears to be, at least in the lower part, not spirally coiled, as in the ordinary gastropods, but straight and central, with the lip spread out all round, trumpet-like. There is some evidence that towards the apex of the spire it is spirally coiled.

Position uncertain; may be more nearly allied to Trochita.

FAMILY STOMATELLIDÆ.

Shell paucispiral, auriform, the last whorl rapidly enlarging to the aperture, nacreous within. Operculum, when present, corneous, multispiral.

Animal too large to entirely enter the shell.

STOMATELLA, Lam.

Etym.—Diminutive of *stoma*, the aperture.

Distr.—33 sp. Cape, India, North Australia, China, Japan, Philippines. *S. imbricata*, Lam. (lxxx, 73). *S. Cumingii*, A. Ad. (lxxxi, 74).

Shell ear-shaped, regular; spire small; aperture oblong, very large and oblique, nacreous; lip thin, even-edged. Operculum circular, horny, multispiral. On reefs and under stones at low-water.

STOMATIA, Helbing.

Etym.—*Stoma*, the aperture.

Distr.—12 sp. Java, Philippines, Torres Straits, Pacific. Under stones at low-water.—CUMING. Fossil: M. d'Orbigny refers to this genus 18 species, ranging from the L. Silurian to the chalk. North America, Europe.

Shell like Haliotis, but without perforations, their place being occupied by a simple furrow; surface rugose, spirally ridged; spire small, prominent; aperture large, oblong, outer margin irregular.

Animal spiral, too large entirely to enter the shell; frontal lobes digitated, foot large, tubercular, greatly produced behind, lateral membrane fringed, ending anteriorly on the left side in a fimbriated crest under the eye-pedicel, and on the right in a slightly projecting fold or gutter leading to the respiratory cavity. Operculum, none.

Stomatia, like Harpa and some nudibranchs, has the power of spontaneously throwing off the hind-part of the foot when the animal is irritated, and Gena exhibits the same peculiarity; specimens in spirits have the foot usually truncated from this cause. Most numerous at the Philippines, on coral reefs, but also found under stones at low-water.

MICROTINA, H. and A. Adams. (Microtis, A. Ad.) Shell suborbicular, depressed, spire but slightly developed; whorls with two small tuberculated ribs; columellar lip twisted; aperture transversely oval. No operculum. Animal as in Stomatia, but the foot with a deep anterior fissure for the head, and with the front edge bilobed. 2 sp. Philippines, New Caledonia. *S. tuberculata*, Ads. (lxxxi, 75).

NIPHONIA, Adams. Shell like Stomatella, but very thin; columellar lip internally thickened, and gradually passing into the outer lip. *S. pulchella*, A. Ad. Japan.

GENA, Gray. Shell subspiral, oblong, auriform, depressed, smooth or striated; spire flattened, nearly obsolete; aperture very large. No operculum. Animal with the front lobes plumose; foot very large, tubercular, posteriorly produced; lateral membrane not fringed, more or less extended, and partially covering the shell. 16 sp. Red Sea, Indian Ocean, Philippines, Australia. *S. striatula*, Ads. (lxxxi, 76).

PHANETA, H. Adams.

Distr.—*P. Everetti*, H. Adams (lxxxi, 77, 78). Siniwan River, Borneo; attached to submerged logs.

Shell imperforate, trochiform; few-whorled, the last carinated,

expanded, with depressed base; aperture large, rounded, subsinuated behind, pearly within; columella revolute, acute; lip simple.

Apparently not an operculated shell. The whole appearance, especially the pearly interior, reminds one of the Trochidæ, and Mr. Adams is evidently mistaken in referring it as he does to the family Valvatidæ.

BRODERIPIA, Gray.

Etym.—Named in honor of W. J. Broderip, Esq., the distinguished conchologist.

Distr.—3 species. Philippines, Grimwood's Island, South Seas.—CUMING. *B. iridescens*, Brod. (lxxxi, 79, 80).

Shell minute, limpet-shaped, with a posterior submarginal, non-spiral apex; aperture oval, as large as the shell, brilliantly nacreous.

VELAINELLA, Vasseur.

Etym.—Named after Charles Velain, a French naturalist.

Distr.—*V. columnaris*, Vasseur (lxxiii, 5). Eocene; Nantes, France.

Shell spiral, dextral, extremely elongated, thick and solid, nacreous within; aperture oval-oblique, peritreme continuous, left margin with a slight columellar swelling.

The nacreous interior brings this into the Trochidæ, but it is very distinct from any of the preceding forms.

FAMILY PLEUROTOMARIIDÆ.

Shell more or less conically elevated, turreted or trochiform, with a marginal slit in the upper part of the outer lip, or a row of perforations in the upper part of the whorl; aperture pearly within.

PLEUROTOMARIA, Defrance.

Etym.—*Pleura*, side, and *tome*, a notch.

Distr.—4 sp. West Indies, Moluccas, Japan. *Pl. Quoyana*, Fischer and Bernardi (lxxxii, 84). Fossil, 400 sp. Cambrian to Cretaceous; North America, Europe, Australia.

Specimens from clay strata retain their nacreous inner layers; those from the chalk and limestones have lost them, or they are replaced by crystalline spar. Pleurotomariæ with wavy bands of color have been obtained in the carb. limestone of Lancashire. In this extensive group there are some species which rival the living turbines in magnitude and solidity, whilst others are as frail as Ianthina.

Shell trochiform, solid, few-whorled, with the surface variously ornamented; aperture subquadrate, with a deep slit in its outer

margin. The part of the slit which has been progressively filled up forms a band round the whorls.

PTYCHOMPHALUS, Agass. (Cryptænia, Desl.) Heliciform or trochiform shells, with an almost smooth surface, a thick callosity covering the umbilical region and a distinct band on the posterior portion of the whorls, terminating at the aperture with a short slit, sometimes a simple fold. The smooth surface and umbilical callosity distinguish it from other Pleurotomariæ. Species numerous. Liassic to Cretaceous. *P. striatus*, Sowb. (lxxxii, 86).

LEPTOMARIA, Desl., 1865. Shell subturbinate, rather thin, generally ornamented with very numerous, subequal spiral striæ, band very narrow, placed near the middle of the whorls, slit in the outer lip very deep, axis solid or hollowed out. Mostly cretaceous to tertiary. *P. amæna*, Desl.

MURCHISONIA, d'Archiac.

Etym.—Named in honor of Sir Roderick I. Murchison.

Distr.—Fossil, 50 sp. L. Silurian to Permian; North America, Europe. *M. intermedia*, Verneuil (lxxxii, 86).

Shell elongated, many-whorled; whorls variously sculptured, and zoned like Pleurotomaria; aperture slightly channeled in front; outer lip deeply notched.

The Murchisoniæ are characteristic fossils of the palæozoic rocks; they have been compared to elongated Pleurotomariæ, or to Cerithia with notched apertures; the first suggestion is most probably correct.

MURCHISONIELLA, Mörch. A single living species is referred to this uncharacterized group. West Indies.

DISOTEKA, Gardner, 1880. Differs from Murchisonia in having two slit-bands. Cret.; England.

PORCELLIA, Léveillé.

Distr.—10 sp. U. Silurian to Trias. Europe. *P. Puzo*, Lev, (lxxxii, 87).

Shell symmetrical, discoidal or planorbiform; periphery with a deep, marginal slit.

POLYTREMARIA, d'Orb.

Syn.—Trochotremaria, Ryckh.

Distr.—Carboniferous; Belgium. *P. catenata*, Kon. (lxxxii, 88).

Shell turbinated, heliciform, periphery pierced by a line of non-tubular perforations.

CATANTOSTOMA, Sandberger.

Distr.—Devonian, Trias. *C. clathratum*, Sandb. (lxxxii, 89).

Shell turbinate, heliciform or bulimiform; last whorl deflected; the peristome incomplete, irregular, slightly varicose on the last

whorl. At the place where this is deflected there is an elongated, kidney-shaped perforation surrounded by somewhat thickened margins; another small perforation is found about the centre of the basis, but in the outer lip it is likewise surrounded with a raised margin.

? Brilonella, Kayser.

Distr.—*B. serpens*, Kayser. Devonian; Germany.

Last whorl unwound and deflected upwards, so that the mouth lays upon the top of the spire; otherwise like Pleurotomaria.

Odontomaria, Roemer.

Distr.—*O. elephantina*, Roemer. Devonian; Eifel.

Shell not spiral, extended-tubular, somewhat curved; mouth with slit terminating an external band.

Trochotoma, Lycett.

Etym.—*Trochus*, and *tome*, a notch.

Syn.—Ditremaria, d'Orb. Rimulus, d'Orb.

Distr.—Fossil, 10 sp. Lias to Coral Rag; Britain, France, etc. *T. Humbertina*, d'Orb. (lxxxii, 90).

Shell trochiform, slightly concave beneath; whorls flat, spirally striated, rounded at the outer angles; lip with a single perforation near the margin.

Temnotropis, Laube.

Distr.—*T. carinatus*, Goldfuss. Trias; St. Cassian.

Shell ear-shaped, with rapidly enlarging keeled whorls, and a very large oval aperture; outer lip sharp with a deep slit, terminating a slit-band on the keel.

Ditremaria, Deslongc.

Distr.—2 sp. Great Oolite and Coral Rag; France and Germany. *D. quinquecincta*, Ziet. (lxxxii, 91).

Shell trochiform; in place of the slit of Trochotoma, there are two elongated oval holes united by a transverse fissure; the base of the shell presents a large callosity, the umbilicus is deeply excavated, and a round tubercle arises from it; the aperture is contracted, and the upper angle of each lip bears a more or less distinct tooth.

Schismope, Jeffreys, 1856.

Etym.—*Schisme*, a slit, and *ope*, a hole.

Syn.—Woodwardia, Fischer, 1861.

Distr.—4 sp. Mediterranean, Japan. Fossil, 1 sp. Miocene; Bordeaux.

Shell like Scissurella, but the spire is laterally compressed, as in Stomatia, and is not so trochiform. The slit in the peristome

of the young shell is converted into a foramen in the adult; it does not commence until the animal is half-grown.

S. striatula, Ph., is a littoral species, whilst all the species of Scissurella inhabit deep water.

Scissurella and Schismope are the analogues respectively to Pleurotomaria and Trochotoma, differing only in size; but in the two former genera the shell is translucent, not nacreous, as in the two latter.

SCISSURELLA, d'Orbigny.

Etym.—Diminutive of *scissus*, slit.

Syn.—Anatomus, Montfort.

Distr.—Europe, 5 living, 4 tertiary species. *S. Bertheloti*, Webb (lxxxii, 92).

Shell minute, thin, not pearly; body-whorl large; spire small; surface striated; aperture rounded, with a slit in the margin of the outer lip; operculate. The young have no slit.

Animal like Margarita; tentacles long, pectinated, with the eyes at their base; foot with two pointed lappets and two long, slender pectinated cirri on each side. Operculum ovate, very thin, with an obscure subspiral nucleus.

No part of the animal is external to the shell. A living example occurred at Hammerfest, in 40–80 fathoms of water; when placed in a glass of sea-water it crawled up the side and scraped the glass with its tongue. It was pale and translucent when living, but turned inky black after immersion in alcohol.

SCHIZOTROCHUS, Monterosato. Operculum very thin; shell trochoidal. *S. crispata* (lxxxii, 93).

SEGUENZIA, Jeffreys.

Distr.—4 sp. Azores, W. Indies, Pernambuco. 718–1000 fms. *S. formosa*, Jeffreys (lxxxii, 94).

Shell globular or conical, glossy, without epidermis, exquisitely sculptured; upper part of the last whorl deeply and widely grooved; pillar abruptly notched below, and exhibiting a small tooth-like process; base either deeply umbilicated or imperforate.

Differs from the other genera by having a broad sutural slit, instead of on the periphery. Operculum very thin, paucispiral.

BASILISSA, Watson.

Distr.—7 sp. Pacific, W. Indies, Canaries, off La Plata, etc., at considerable depths. *B. lampra*, Watson.

Shell conical, carinate, umbilicate, pearly, last whorl sinuate above; columella straight, thin, excavated above, angulate but scarcely dentate below; aperture rhomboidal, the margin not continuous nor joined by palatal callus.

The sinus is wide, open, shallow, not deep-cleft as in Seguenzia,

and it lacks the sharp tooth on the pillar with strongly marked sinus above and below it, of that genus.

Specimens were obtained by the Challenger expedition at depths varying from 390 to 1900 fathoms.

FAMILY BELLEROPHONTIDÆ.

Shell globular, nautiliform, symmetrically convoluted; periphery carinated or sulcated, ending in a slit of the middle portion of the outer lip.

A large group of palæozoic fossils, the natural relations of which are very doubtful. They have been placed with the Cephalopoda, Bullidæ, Pteropoda, etc., but the slit shell appears to indicate closer affinities with the Pleurotomariidæ, and the best modern systematists place them in the vicinity of that family.

BELLEROPHON, Montfort, 1808.

Syn.—Microceras, Hall.

Distr.—150 sp. Cambrian to Carb.; North America, Europe, Australia, India. *B. striatus*, d'Arch. (lxxxii, 95).

Shell symmetrically convoluted, globular, or discoidal, strong, few-whorled; whorls often sculptured; dorsally keeled; aperture sinuated and deeply notched on the dorsal side.

Microceras, Hall, appears to be founded on the embryonic volutions of a Bellerophon.

WARTHIA, Waagen, 1880. Smooth, globular, not umbilicated, without slit-band, and having a tolerably deep rounded sinuosity on the outer lip; inner lip only very slightly callous. Fossil. Salt Range, India. *B. brevisinuata*, Waagen (lxxxii, 96, 97).

MOGULIA, Waagen, 1880. Globular, without well-developed slit-band; mouth oval, outer lip with a shallow angular emargination, inner lip callous; no spiral sculpture. *B. regularis*, Waagen (lxxxii, 98, 99). Carboniferous; India. Possibly = Warthia.

PATELLOSTIUM, Waagen, 1880. Mouth very much expanded and the lips spread out patella-like, the inner lip not being cut out where it touches the preceding volution. *Bell. macrostoma*, Proem. *Bell. megalostoma*, Eichw.

WAAGENIA, L. G. de Koninck, 1882. Shell subglobular, usually a little higher than wide, and slightly compressed on the sides; whorls completely embracing, leaving no trace of umbilical opening, that region being covered with a callus which appears to have been deposited by a special organ, of which the related genera are deprived; slit-band narrow, a little inflated; surface covered with small imbricated plications or fine lines of growth, and showing a pattern of coloring. Distinguished from Bellerophon by the umbilical callus. *Distr.*—3 sp. Carboniferous; Europe. *W. Ferussaci*, d'Orb.

BUCANIA, Hall, 1847.

Syn.—Phragmostoma, Hall, 1862. Centrotheca, Salter.

Shell planorbiform, the whorls exposed equally above and below, with revolving striæ; last whorl much enlarged at the aperture. Silur., Carb. *B. expansa*, Hall (lxxxii, 100, 1).

BUCANELLA, Meek. Shell without slit-band.

TROPIDODISCUS, Meek. Strongly compressed, disciform, widely umbilicated, with a high keel and very short incision in the outer lip; callosity on the inner lip very little developed. Silur., Carb. *B. curvilineata*, Conr. (lxxxii, 2, 3).

TREMANOTUS, Hall, 1864. (Salpingostoma, Roemer, 1876.) Like Bucania, but in place of the slit-band, a row of oval openings on the last whorl. Mouth strongly expanded. Silurian. *T. alpheus*, Hall.

TUBINA, Barrande, 1868. Like Tremanotus, but with three rows of openings instead of one, on which long hollow tubes are placed. Mouth very little expanded. Silurian; Bohemia.

EUPHEMUS, M'Coy, 1844. Umbilicus absent or small, shell with spiral folds, not continued on the last whorl, aperture slightly contracted, lip sometimes emarginate, no distinct slit-band. Carb.; Gt. Brit., Salt Range, India. *B.* (*Euphemus*) *Indicus*, Waagen (lxxxii, 4).

TROPIDOCYCLUS, Koninck, 1882. *T. curvilineatus*, Conr.

STACHELLA, Waagen, 1880. More or less globular, smooth, unsymmetrical, mostly umbilicated on one side and with a closed umbilicus on the other; slit-band distinct, but superficial, slit shallow. Fossil. Salt Range, India. *B. bifrons*, Waagen (lxxxii, 5, 6).

PHRAGMOSTOMA, Hall, 1861. Mouth much expanded, with the slit forming a sinus; slit-band well marked; inner lip expanded into a septum. Devon.; New York. Is very closely related to Carinaropsis, Hall.

BELLEROPHINA, d'Orb.

Distr.—Cretaceous; Europe. *B. Vibrayi*, d'Orb. (lxxxii, 7).

Shell subsymmetrical, globular, the whorls embracing as in Bellerophon, but without sinus; sides slightly unequal, the spire-whorls perceptible above, while below the umbilicus is very narrow.

CARINAROPSIS, Hall.

Distr.—Fossil, 2 sp. Silurian; America. *C. carinata*, Hall.

Shell having a patelloid aspect. Spire usually attenuated; body-whorl expanded abruptly; cavity shallow, presenting a kind of septum as in Crepidula.

CYRTOLITES, Conrad.

Etym.—*Kurtos*, curved, *lithos*, stone.

Distr.—Fossil, 13 sp. L. Silur.—, Carb.; N. Am., Eur. *C. ornatus*, Conrad.

Shell thin, symmetrical, horn-shaped or discoidal, with whorls more or less separate, keeled and sculptured.

CYRTONELLA, Hall, 1879. Shell ovoid, trumpet-shaped; volutions one or more in the same plane; apex minute, making about a single turn, and rapidly expanding beyond, peristome entire; dorsum angular or subcarinate; surface sculptured. *C. mitella*, Hall. Devon.; N. Y.

FAMILY MACLUREIDÆ.

MACLUREA, Lesueur.

Etym.—Named after William Maclure, the first American geologist.

Distr.—Fossil, 12 sp. Palæozoic; North America, Scotland (Ayrshire, M'Coy). *M. Logani*, Salter lxxxii, 8, 9). *M. magna*, Lesueur (lxv, 10).

Shell discoidal, few-whorled, longitudinally grooved at the back, and slightly rugose with lines of growth; dextral side convex, deeply and narrowly perforated; left side flat, exposing the inner whorls. Operculum sinistrally subspiral, solid, with two internal projections, one of them beneath the nucleus, very thick and rugose.

This singular shell abounds in the "Chazy" limestone of the United States and Canada; sections of it may be seen even in the pavement of New York. "We are indebted to Sir W. E. Logan, of the Geological Survey, Canada, for the opportunity of examining a large series of silicified specimens, and of figuring a perfect shell, with its operculum *in situ*. It has more the aspect of a bivalve, such as *Requienia Lonsdalii*, than of a spiral univalve, but has no hinge. Many of the specimens are overgrown with a zoophyte, generally on the convex side only, rarely on both sides.

"The Maclurea has been described as sinistral; but its operculum is that of a dextral shell; so that the spire must be regarded as deeply sunk and the umbilicus expanded, as in certain species of Planorbis; unless it is a case conversely parallel to Atlanta, in which both shell and operculum have dextral nuclei. The affinities of Maclurea can only be determined by careful examination and comparison with allied, but less abnormal forms, associated with it in the oldest fossiliferous rocks; its relation to Euomphalus (p. 218) is not supported by the evidence of Sir W. Logan's specimens."—WOODWARD.

FAMILY HALIOTIDÆ.

Shell spiral, ear-shaped, with a greatly expanded, flattened body-whorl, and large basal aperture; dorsally perforated in a

single spiral series; interior pearly, with a large central muscular scar. No operculum.

Animal with a short muzzle and subulate tentacles; eyes on pedicels at the outer bases of the tentacles; branchial plumes 2; mantle-margin with a posterior (anal) fold or siphon, occupying the slit or perforation in the shell. Operculum lobe rudimentary; lingual dentition similar to Trochus.

The species are remarkable for the beauty and variety of their shells and are mostly tropical in distribution. One small species is eaten by the inhabitants of the Channel Islands (Gt. Britain), and others are important articles of diet in China, Japan, and among the Chinese settled in California. The shells are largely used for the manufacture of mother-of-pearl ornaments and for inlaying in papier-maché work.

HALIOTIS, Linn.

Ear-shell. *Etym.—Halios*, marine, and *ous* (*otos*), an ear.

Distr.—75 sp. Britain, Canaries, Cape, India, China, Australia, New Zealand, Pacific, California. Fossil, 4 sp. Cretaceous. *H. Midæ*, Linn. (lxxxiii, 10). *H. gigantea*, Chemn. (lxxxiii, 11).

Shell ear-shaped, with a small flat spire; aperture very wide, iridescent; exterior striated, dull; outer angle perforated by a series of holes, those of the spire progressively closed.

Animal with fimbriated head-lobes; side-lobes fimbriated and cirrated; foot very large, rounded. Lingual teeth, median small; laterals single, beam-like; uncini about seventy, with denticulated hooks, the first four very large.

DERIDOBRANCHUS, Ehrenberg. Shell large and thick, like Haliotis, but entirely covered by the thick, hard, plaited mantle of the animal. *D. argus*. Red Sea.

TEINOTIS, H. and A. Adams. Shell depressed, elongated, ear-shaped; spire small, and placed posteriorly; hinder part of the foot in the animal stretches far over the shell. 2 sp. East Indies. *H. asinina*, Linn. (lxxxiii, 12).

PADOLLUS, Montfort. A strong, rounded, spiral rib within the line of perforations, and forming a spiral sulcus inside the shell. Form rounded-oval, with rather large, sublateral spire. *H. tricostalis*, Linn. (lxxxiii, 13).

SULCULUS, H. and A. Adams. Very like Padollus, having the same dorsal rib, but the form of the shell is more elongated, and the spire smaller and subterminal. *H. Janus*, Reeve (lxxxiii, 14).

SUBORDER *EDRIOPTHALMA*.

Shell conical, not spiral, porcellanous. No operculum. Eyes sessile.

GLYPHIS, Carpenter. (Capiluna, Gray.) An
edge of the mantle fimbriated, and covering the
shell. Shell with the surface cancellated, the mar
callosity often truncate, sometimes laminated.
Rimuliform, with the spire absorbed in the incre
F. inæqualis, Sowb.

CLYPIDELLA, Swainson. Shell oval, rugose, slig
truncated at the anterior extremity; perforation
tral or somewhat anterior. Mantle-margin dou
scalloped and fringed, covering the sides of t
siphon surrounded by a fimbriated membrane; fo
and tubercular, with a series of rudimentary, tenta
on the sides near the fore-part. *F. pustulata*, Lan

FISSURELLIDÆA, d'Orb. Shell small relative to t
animal, depressed; perforation large, oval, central,
border on the inner face; margin smooth. Mantle
oped, thickened at the edges and nearly covering
very large and elongated. *F. hiantula*, Lam. (lxx

MACROSCHISMA, Swainson. Shell square-oval, r
truncate at the end; perforation very large, subtr
gated. Animal large, larviform, greatly elong
shell situated towards the posterior end. *F.*
(lxxxiii, 19).

PUPILLA, Gray. Shell depressed, nearly smoot
large, subcentral, oblong; margin white. Man
entirely covering the shell, orifice of anal siphon
at the anterior third; foot granulated, shorter th
The shell may be readily known by the shar
border, which is received into the integument of
one of the valves of a Chiton. It is an inhabi
Africa. *F. apertura*, Born (lxxxiii, 20).

RIMULA, Defrance.

Etym.—Diminutive of *rima*, a fissure. *Syn.*—
Distr.—Several species found on sandy mud a
dredged in from 10 to 25 fathoms. Philippi
Fossil, 3 species. Bath Oolite to Coral Rag; Brita
R. exquisita, Ads. (lxxxiv, 32).

Shell thin and cancellated, with a perforation ne
margin.

PUNCTURELLA, Lowe. (Cemoria, Leach. Di
Shell conical, elevated, with the apex recurved;
front of the apex, with a raised border (septu
surface cancellated. Mantle-margin simple, anal
ment, tubular, with six papillæ in front and fou
with a rudimentary operculigerous lobe. *Distr.*—
land, Boreal America, Norway, North Britain, Te

In 20 to 100 fathoms water. Fossil, in the glacial formations of North Britain. *R. Noachina*, Linn. (lxxxiv, 33).

CRANOPSIS, Adams. Fissure about the middle of the anterior side; an internal vaulted chamber over the foramen, resembling that of Puncturella. *Cr. pelex*, Adams (lxxxiv, 34, 35), from the China seas, is the type, and one or two additional species have been since described.

SEMPERIA, Crosse. (Named after M. O. Semper, of Altona.) Shell conical, apex posteriorly recurved, anteriorly fissured; the fissure is marginal in the young shell, but in the adult the margins grow around it so that it becomes subdorsal, or separated from the margin externally, though connected with it internally by a channel. Embraces at different growth-stages characters of Rimula, Emarginula, Clypidina. 2 sp. Madeira. Fossil; Paris basin. *S. elegans*, Crosse (lxxxiv, 36).

EMARGINULA, Lam.

Etym.—Diminutive of *emarginata*, notched.

Syn.—Nesta, H. Adams.

Distr.—40 sp. West Indies, Britain, Norway, Philippines, Australia. Range from low-water to 90 fathoms. Fossil, 40 sp. Carboniferous—. *E. fissura* (lxxxiv, 37).

Shell oval, conical, elevated, with the apex recurved; surface cancellated; anterior margin notched. Muscular impression with recurved points. The nucleus (or shell of the fry) is spiral, and resembles Scissurella. The anterior slit is very variable in extent. The animal of Emarginula (and also of Puncturella) has an isolated cirrus on the back of the foot, perhaps representing the operculigerous lobe.—FORBES. Lingual dentition (xii, 50), median teeth subquadrate; laterals four, oblong, imbricated; uncini about 60, the first large and thick, with a lobed hook, the rest linear, with serrulated hooks.—LOVÉN.

SUBEMARGINULA, Blainv. (Hemitoma, Swain. Siphonella, Issel. Montfortia, Recluz.) Anterior margin with a slight channel and a canal-like prolongation of it proceeding towards the apex, on the inside face of the shell. *E. octoradiata*, Sowb. (lxxxiv, 37).

ZEIDORA, Adams. Shell like Emarginula, with the margin of the aperture crenulated and anteriorly deeply fissured, but there is posteriorly an internal, flat, semilunar septum present, which distinguishes this subgenus from any other Fissurellidæ. *E. reticulata*, A. Ad. (lxxxiv, 39, 40).

DESLONGCHAMPSIA, M'Coy, 1850. (Dedicated to Dr. Eudes Deslongchamps, the renowned French palæontologist.) Shell patelliform, apex acute, excentric; with a wide longitudinal anterior sulcus, produced into a rounded lobe. Fossil, 3 sp. Lower Oolite; England, Normandy, Galicia. *D. Eugenei*, M'Coy (lxxxiv, 41).

PARMOPHORUS, Blainv.

Etym.—*Parme*, a shield, and *phoreus*, a bearer. Duck's-bill limpet. *Syn.*—Scutus, Montf.

Distr.—12 sp. East Indies, Philippines, Australia. Fossil, 3 sp. Eocene; Paris basin. *P. australis*, Bl. (lxxxiii, 21).

Shell lengthened-oblong, depressed; apex posterior; front margin incurved. Muscular impression horseshoe-shaped, elongated. The shell is smooth and white, and permanently covered by the reflected borders of the mantle. The animal is black, and very large compared with the shell; its sides are fringed with short cirri, and its eyes sessile on the outer bases of thick tentacles. Occurs in shallow water, walking freely.

TUGALIA, Gray. Shell cancellated, with crenulated margin. *P. elegans*, Gray.

COCCULINA, Dall.

Distr.—2 sp. New England, deep waters. *C. Rathbuni*, Dall.

Shell patelliform, apex posteriorly inclined, with a deciduous spiral nucleus; margin entire.

Animal blind, with prominent head and muzzle; two tentacles; gill single, plumose, asymmetrical, extending between the under surface of the mantle and the foot (from a point above and behind the head) backward on the right side; anal opening above and behind the head; mantle-margin plain; margin of the foot without processes, excepting a single filament on each side. Radula with a small or moderate rachidian tooth, three inconspicuous and a fourth larger, dentate laterals, uncini numerous. The male has a verge permanently exserted from the inner side of the right tentacle.

The shell resembles that of the Patellidæ, but the animal is more nearly allied to the Fissurellidæ. Mr. Dall has formed a family for the two species known.

ADDISONIA, Dall.

Etym.—In honor of Prof. Addison E. Verrill, of Yale College.

Distr.—2 sp. New England, Mediterranean Sea. *A. paradoxa*, Dall.

Shell ovate, subconical, strongly asymmetrical with curved apex; no epidermis; margin plain.

Animal with two tentacles; no eyes; foot and mantle without tubercles or processes; gill composed of leaflets as in Patella, the series starting on the right behind the head and continued within the mantle-edge backward, the body of the animal being asymmetrically placed with regard to the aperture of the shell to afford room for the enormous series of branchial leaflets; anus opening behind and above the head slightly to the right of the median line, and indicated by a small papilla. Radula with

a large, simple rachidian tooth with, on each side, two large, simple, transverse laterals, followed by two minute ones, and a large outer lateral with a strong tridentate cusp, outside of which is a single scale-like flat uncinus, bearing an elongated, thickened ridge, but no cusp.

For this genus Mr. Dall has proposed a new family; he states that it might be incorporated with Cocculinidæ, "were it not for the differences in the branchiæ and in its dentition."

Family PATELLIDÆ.

Shell wholly external, dish-shaped, with apex anteriorly directed; animal with two short tentacles, a non-extensible muzzle; branchiæ external or none; renal and anal aperture situated above the neck, between body and mantle-edge; no copulatory or external genital organs; mouth provided with horny jaw, and long radula with numerous peculiar black, opaque teeth, and pellucid or colored plates or bosses; metamorphosis of the embryo taking place in the egg, which is fertilized in the ovary.

The Limpets have been very thoroughly studied by Mr. Wm. H. Dall,* who has proposed an elaborate classification of them, including ordinal and subordinal as well as family and generic characters. I have mainly followed Mr. Dall's system in the diagnoses and sequence of the groups, but without giving them the same systematic values:—for example, I have used above his characters of the Order Docoglossa for the family Patellidæ, thus making the family more comprehensive than in his sense, and corresponding more nearly in conchological importance with the other families in this work. Similarly Mr. Dall's suborders correspond nearly with my subfamilies and his family characters are here treated as generic. The order Docoglossa is, as its name implies, founded upon peculiarities in the arrangement of the lingual dentition (xii, 51), but already two forms of limpets have been discovered which by their dentition cannot be placed in this order. Cuvier united the Patellidæ and Chitonidæ in his order Cyclobranchiata, characterized by the arrangement of the gills in a circle surrounding the body, but more recent investigators have ascertained a considerable diversity of gill-arrangement among the limpets, so that this term will no longer apply to them as a whole, although many of them agree with the Chitons in this feature.

Subfamily *LEPETINÆ*.

Animal without branchiæ. Embryonic shell spiral.

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* See his papers in *Am. Jour. Conch.*, v, vi, and *Proceedings of the National Museum*.

LEPETA, Gray.

Syn.—Cryptobranchia, Midd. pars. Propilidium, Gray, not Forbes and Hanley. Pilidium, Stimpson, not F. and H. nor Midd.

Shell conical, patelliform, with a subspiral nucleus, which is generally lost in early life, the permanent apex being erect or anteriorly directed.

Animal without eyes, without lateral teeth, with a rachidian tooth, and erect uncini; muzzle with an entire margin, which is extended backward into a tentacle-like filament on each side.

LEPETA (restricted), Dall. Apex erect. Rachidian tooth tricuspid, the middle cusp much larger; lateral teeth simply cuspidate. *L. cæca*, Müll. (lxxxiv, 42).

CRYPTOBRANCHIA (restricted), Dall. Apex inclined anteriorly. Rachidian tooth with three nearly equal denticles; uncini broadly hooked. *L. concentrica*, Midd. (lxxxiv, 43).

LEPETELLA, Verrill. Shell as in Lepeta. Animal differing in having eyes and in being provided with true lateral teeth and also with scale-shaped uncini. *L. tubicola*, Verrill. 200 to 400 fms., off New England coast.

PILIDIUM, Forbes. (Iotha, Gray. Ergina, Jeffreys.) Shell patelliform, apex anterior, generally deep-colored. Mantle fringed with cilia; rachidian tooth long, rhomboidal, bearing a very large black cusp with a simple denticle on each side, laterals with broad cusps striated beneath and obliquely bent, shafts slender. *P. fulvum*, Forbes. Northern America and European coasts.

SUBFAMILY *ACMÆINÆ.*

Embryonic shell conical. Animal usually having eyes and a plumose, cervical, external gill, with or without a marginal cordon; rachidian tooth rarely present, lateral teeth three in number.

ACMÆA, Esch.

Syn.—Tectura, Aud. Patelloida, Quoy and Gaim. Lottia, Gray. Iotha, Forbes. Patelloidea, Couth. Tectura, Gray. Scutellina, Gray. Scutella, Brod.

Distr.—25 sp. Mostly W. Coast of N. America, Europe, etc. *A. mitra*, Esch. (lxxxiv, 44).

Shell solid, patelliform; apex erect or anteriorly inclined. Animal. Muzzle frilled, produced at the lower anterior corners into two lappets or tubercles; no marginal cordon, the cervical gill alone present.

COLLISELLA, Dall. Muzzle-frill simple, entire, not produced into lappets or tubercles. *A. spectrum*, Reeve (lxxxiv, 45, 46). *A. variabilis*, Sowb. (lxxxiv, 47).

SCUTELLINA, Gray. Shell with a broad margin internally. 7 sp. Red Sea, Philippines, Pacific, Panama. *A. crenulata*, Brod.

PECTINODONTA, Dall.

Distr.—*P. arcuata*, Dall. West Indies.

Shell resembling Acmæa, with a blunt subcentral apex.

Animal blind, with the front part of the head between the tentacles and above the muzzle much produced upward and forward, extending considerably further forward than the end of the muzzle. Muzzle marginated, with lappets at the outer corners. Jaw thin, translucent. Gill exactly as in Acmæa; sides of foot and mantle-edge simple, nearly smooth.

LOTTIA, Gray.

Syn.—Tecturella and Tecturina, Carp.

Distr.—*L. gigantea*, Sowb. (lxxxiii, 22). West Coast of N. America.

Shell patelliform, depressed, the apex anterior.

Animal with a single cervical branchia, but also furnished with a branchial cordon of laminæ between the mantle-edge and the foot, extending as far forward as the adductor muscle on each side and continuous behind; frill of the muzzle without lappets. The typical and only species is among the largest and most active of limpets, the shell attaining three inches in length.

SCURRIA, Gray.

Distr.—Several sp. West Coast of North and South America. *S. scurra*, Lesson (lxxxiv, 48).

Shell patelliform, conical, elevated, rather thick and of rude growth. Branchiæ completely surrounding the body, as in Patella, but having also the cervical plume of Acmæa; muzzle without lappets.

SCURRIOPSIS, Gemmellaro. Shell with radiating riblets crossed by concentric growth-lines. Jurassic.

SUBFAMILY *PATELLINÆ.*

Shell conical, with the apex turned forward; muscular impression horseshoe-shaped, open in front, as in the preceding groups.

Animal. Gills forming a row of leaflets surrounding the body; no cervical plume-like gill; radula provided with three lateral teeth on each side, and three uncini; rachidian tooth rarely present (xii, 51).

The continuous series of branchial lamellæ forming a fixed cordon between the mantle and foot, together with peculiarities of their lingual dentition, serve to distinguish this subfamily from the preceding one. These animals are strictly littoral in habit, living upon the rocks between tide-marks; they are chiefly sedentary, adhering firmly by atmospheric pressure, and

feeding on the sea-weed within reach of their long ton during the night-time, however, they make short excur indicated by the irregular tracks they form in their moven They possess the power of excavating the surface of the r but whether by mechanical attrition, aided by the hard cr line spicula with which the foot is strengthened, or by th bonic acid disengaged in respiration, has not been posit determined; perhaps both agencies are employed, the being more effective with limestone rocks, the former wh sometimes occurs, the roosting place is excavated in timbe

PATELLA, Linn.

Etym.—Patella, a dish.

Syn.—Scutellastra, Cymbula, Olana, H. and A. Adams. I Tournefort. Patellites, Walch. Patellaria, Llhwyd. Ce H. Adams.

Distr.—150 sp. World-wide. Fossil, 100 sp. Silur *P. cærulea* (lxxxiv, 49).

Shell conical, more or less depressed, oval at the base; subcentral or anterior, from which usually radiate ribs, are frequently nodose; mostly crenulated on the inner m

Animal. Foot smooth, branchial lamellæ subequal all ar

The Patellæ or limpets are not eaten in the United State in Europe, especially upon the British Coasts, there is a consumption of them; roasted, boiled or made into soup are very palatable. They were eaten by primitive man, ar shells were formed into ornamental necklaces, occurring i most ancient cromlechs or subterranean burial chambers. are very extensively used as bait also; in Berwick alone the supply was exhausted, nearly twelve millions of limpe said to have been gathered annually for this purpose—a pr requiring alertness and skill, for, as Wordsworth says:—

"And should the strongest arm endeavor
The limpet from its rock to sever,
'Tis seen its loved support to clasp,
With such tenacity of grasp,
We wonder that such strength should dwell
In such a small and simple shell.'

" Bouchard-Chantereaux says that he had often seen li (*Patella vulgata*) crawling, especially just after the tid gone out. The young limpet moves freely about, and shi quarters; but after attaining a growth of probably a few it affixes itself to a particular spot, which it only quits covered by the sea, on the return of each tide. If it sett a hard and rugged rock, the circumference of the sh moulded to fit the irregular surface of its abode; the b attachment is then bleached. Should the rock be soft, it s

out, by degrees, with its muscular foot a cavity of a greater or less depth. Specimens are not unfrequently found, on impure limestone, which are constricted or indented at the edges, in consequence of the excavation having been hindered by the greater hardness of one side of the spot occupied by these limpets. The animal feeds on small, delicate sea-weeds of a foliaceous kind, as well as on *Melobesia polymorpha*, that encrust the rocks at low-water, by means of its long tongue, which is coiled spirally, like the main-spring of a watch, set around with cogs. This instrument is thrust out from side to side, and when charged with food, it is withdrawn into the stomach, unloaded, and again put forth. The mark left on the face of a rock, coated with a film of the fine sea-weed mentioned above, by a limpet after grazing, resembles the track of a sea-worm; indeed, a late eminent geologist had a large slab thus marked cut out of the rock, and sent to him with great care, in order to publish the supposed discovery of a new Annelidan ichnolite in the old red sandstone. Fortunately, the mistake was pointed out to him before he proceeded further. Each limpet appears to have its own feeding-ground or pasturage; its tracks are sometimes numerous, and deviate in different directions. Mr. Peach has ascertained that it does not retire in the winter to deeper water, on the coast of Caithness, and that it always returns home before the ebbing tide leaves it dry. Its firm adhesion to the rock is extraordinary. In order to test the strength of its tenacity, Reaumur suspended a weight of 28 to 30 lbs. from the shell of a limpet attached to a stone. This weight it sustained for some seconds; less weight failed to overcome its resistance. He attributes the adhesive force not to muscular action, but to an invisible glue which exudes from the granulated base or sole of the foot. It may be also caused by the adaptation of the surface of this part of the animal to the frequent, although often minute, inequalities of the stone, although the glutinous and viscous fluid, which is secreted by numerous glands in the foot, appears to be the principal agent."—JEFFREYS, *British Conchology*.

PATINELLA, Dall. Shell solid, porcellanous, with an erect subcentral apex. Foot bordered by a scalloped frill, interrupted only in front. *P. Magellanica*, Gmel. (lxxxiii, 23).

NACELLA, Schum. Shell with the apex submarginal, anterior; pellucid, thin or corneous. Animal with the branchial cordon complete before and behind, the laminæ persistent but diminishing in size before the head; sides of the foot with scalloped lappets. *P. cymbularia*, Lam. (lxxxiii, 24).

HELCION, Montfort. Shell ovate, radiately ribbed (pectinated); apex anterior, submarginal; aperture ovate, edge crenated. Branchial cordon interrupted in front; sides of the foot smooth. *P. pectinata*, Linn. (lxxxiv, 50).

HELCIONISCUS, Dall. Shell solid, heavy, moderately elevated, with a subcentral inconspicuous apex. Branchial cordon interrupted in front, ending abruptly on each side, at the anterior ends of the adductor; sides of foot and mantle-edge smooth; inner uncinus hardly raised above the level of the lingual ribbon, second lateral tooth largest: *P. exaratus*, Nutt. (lxxxiii, 25).

PATINA, Leach. (Nacella H. and A. Adams, in part. Ansates, Sowb.) Shell with the apex subterminal, anterior; smooth, thin, semipellucid or horny. Animal with the branchial cordon interrupted in front; teeth with the inner two series parallel, third series with a larger denticulate cusp, posterior, three uncini on each side the radula. *P. pellucida*, Linn. (lxxxiv, 51).

ANCISTROMESUS, Dall. Shell white, apex subcentral, obsoletely radiately ribbed. Animal blackish, with complete branchial cordon, the lamellæ being long and slender, subequal; sides of foot smooth; radula with a simple rachidian tooth, the two inner laterals on each side anterior to the third pair, which are large and quadridentate, uncini simple.

A. Mexicanus, Brod. is the largest living limpet, the shell attaining a length of from 8 to 14 inches. It is frequently used as a wash-basin in Central America, and inhabits the West Coast, extending northwards to Acapulco, etc.

METOPTOMA, Phillips. (Tryblidium, Lindström, 1880.) Shell like Helcion, with a broad but slightly or obsoletely marked scar below the apex, truncate or somewhat insinuated on the margin. Palæozoic; United States, Europe. *P. solaris*, Kon. (lxxxiv, 52).

The following subgenera of Patella occur in the work of Messrs. H. and A. Adams. They are not recognized by Mr. Dall on account of the insufficiency of their distinctive characters; like him I have placed them in the synonymy—but give their descriptions.

SCUTELLASTRA, H. and A. Adams. Shell coarsely ribbed, the ribs causing long projections of the margin. *P. longicosta*, Lam. (lxxxiii, 26, 27).

CYMBULA, H. and A. Adams. Shell oblong, laterally compressed, with radiating striæ and recurved apex. *P. compressa*, Linn. (lxxxiii, 28).

OLANA, H. and A. Adams. Shell contracted in front; apex obtuse. *P. cochlear*, Born. (lxxxiii, 29).

LEPETOPSIS, Whitfield, 1882.

Type.—*L. Levettii*, White. Carboniferous; Indiana.

Shell patelliform, more or less regularly round or oval, apex subcentral, posterior to the middle and directed backward, the nucleus dextrally coiled; muscular imprint horseshoe-shaped, open (?) in front, consisting of an irregular narrow band which

expands more or less at the anterior extremities; surface of the shell marked by six very indistinct radiating lines, two anterior, two posterior, and two lateral.

ORDER POLYPLACOPHORA.

Animal symmetrical, with a broad foot; no eyes or tentacles; head extensible into a proboscis; mouth furnished with jaws and lingual ribbon; branchiæ posterior, marginal, between the mantle and foot; heart median; intestine straight, anus posterior; sexes united in the same individual.

Shell when present multivalve, consisting of eight separate pieces inserted upon the back of the animal and surrounded by a mantle-border.

FAMILY CHITONIDÆ.

Shell composed of eight separate transverse imbricating plates, lodged in a coriaceous mantle, which forms an expanded margin around them. Dentition (xii, 52).

The following description of the Chitones is illustrated, as to the shell, lxxxiv, 53, 55, 56; lxxxv, 54.

In all Chitons with exposed valves, the seven posterior valves are divided more or less plainly by lines radiating from the apex to the opposite anterior edge. The sculpture of the posterior triangular areas (areæ laterales) thus cut off is almost uniformly like that of the whole anterior valve and the part behind the apex (mucro) of the posterior valve. The central or anterior triangles (areæ centrales) are sculptured alike, but generally in a different pattern from the sides. The areæ laterales are usually raised a little above the rest. It is very rare that the bounding diagonal lines cannot be traced, and they usually correspond to the slit in the side-laminæ of insertion, which project into the zone or girdle, and are free from the peculiar porous superficial layer characteristic of the exposed test in the whole group of Chitons. This superficial layer usually projects over the anterior and posterior laminæ of insertion or teeth (dentes) in the first and last valves, forming what Dr. Carpenter terms the "eaves" (subgrundæ). These may exhibit the spongy character of the layer of which they are formed, or may be varnished over at their edges with a thin layer of true shelly matter, as in the Ischnoid group. In the typical Chitons they are short, leaving the teeth projecting; in the Mopaloids they are hardly developed, and in some groups they quite overshadow the teeth.

In many groups there is a small portion of peculiar sculpture marked off along the ridge of the median line of the back. This is the area jugali, and corresponds to the sinus or space between the inner terminations of the two anterior sutural laminæ which

pass forward from each of the posterior seven valves under the valve in front. The sutural laminæ are also destitute of the porous layer. The sinus is either open, or part of the jugular area projects forward between the sutural laminæ, forming a false apex; or a keystone-like piece, either solid, or fimbriated like the teeth of a comb, may exist between the laminæ and partly fill the sinus. The sinus posticus is the wave, notch or indentation which in some genera is found in the posterior edge of the posterior valve. In some of the irregular Chitons posterior sutural laminæ are found, but these are very exceptional.

In the vast majority of genera, the side-laminæ of insertion have only one slit on each side of the valve; occasionally a valve may be abnormal in a regular species, and the number of slits in the anterior and posterior valves may vary within moderate limits.

The girdle (zona), which is distinct from the true mantle, is variously ornamented with scales, bristles, spines, down or hairs, either singly or combined, which exhibit most beautiful forms tolerably constant in generic groups, and worthy of a special and exhaustive research. These may be solid or hollow, shelly or keratose, single or combined in bunches, and in some forms are hollow and annulated, precisely like the setæ of brachiopods. In certain genera they issue from pores, usually at the sutures, and these pores have a certain value as a systematic character, but much less than has been assigned to them by some authors.

The Chitons in the adult condition are destitute of eyes or tentacles, and exhibit evidences of degradation anteriorly. The intestine is straight and the anus is always median and posterior; on each side of it are the sexual openings or fenestræ. These may open by several slits or pores directly into the perivisceral cavity, or form the aperture of a sexual duct. The gills are composed of a row of branchiæ, starting from near the tail, extending a third (posticæ), half (mediæ), or all the way (ambientes) towards the head, each leaflet of which corresponds to a whole branchial plume, such as is found in Acmæa. Each single gill is conical, with the lamellæ projecting inwards, somewhat resembling in outline the shell of Carinaria. The mantle, inside the coriaceous margin of the girdle, often forms a lamina of fringe. A lappet called the "veil" generally surrounds the front of the rostrum, which has sometimes a double veil. The muzzle is semicircular, usually plain, and exhibits a tendency to form a lobe at the two posterior corners. The radula is always present and, as in the limpets, is very long; lingual teeth three, median small, laterals large, with dentated hooks, uncini five, trapezoidal, one of them erect and hooked. Like the limpets Chitons possess a laminated crop before the true stomach. The nervous system beautifully worked out by Brandt in a paper singularly over-

looked by most writers, is also comparable with that of *Patella vulgata* (simultaneously examined and figured), though by no means identical. The cephalic ganglia appear to be suppressed, forming another evidence of the degeneration or want of development of the cephalic region of this group.

The above characters are mostly as given by Mr. Wm. H. Dall (*Proc. Nat. Mus.*, 1, 283), who has very carefully studied the Chitons. He has published an elaborate classification of the group, mainly based upon characters of the valves and their surrounding girdle—a classification which is largely founded upon the studies of the late P. P. Carpenter. I have adopted the groups of these eminent naturalists almost throughout, but not usually with the values originally assigned to them, believing that most of their genera had better, at least for the purposes of the present work, be considered subgenera. The Chitons are constituted an order, Polyplacophora, by Gill, Dall, etc., the main character of which is derived from the divided shell; this is the principal distinction from the limpets, with which these mollusks have many points of analogy. Hubrecht forms for the Chitons, etc., a class Amphineura, embracing the orders Solenogastres and Chitones.

CHITON, Linn.

Etym.—*Chiton*, a coat of mail.

Distr.—More than 250 species are known; they occur in all climates throughout the world; most abundant on rocks at low-water, but frequently obtained by dredging in 10–25 fathoms. Some of the small species range as deep as 100 fathoms. North and South America, West Indies, Europe, South Africa, Australia, New Zealand, and Sitka. Fossil, 50 sp. Silurian—. *C. squamosus*, Linn. (lxxxv, 57).

The generic description is equivalent to that of the family.

Mr. Guilding says of the West Indian species (and his remarks will in most particulars apply to others), "They seem to feed entirely by night. Though they remain stationary during the day, when disturbed they will often creep away with a slow and equal pace, often sliding sideways, and creeping under the rocks and stones for concealment. If accidentally reversed, they soon recover their position by violently contorting and undulating the zone; and for defense they sometimes (when detached) roll themselves up like wood-lice. Some of the larger kinds, especially of Acanthopleura, are eagerly devoured by the lower orders in the West Indies, who have the folly to call them 'beef;' the thick fleshy foot is cut away from the animal and swallowed raw, while the viscera are rejected. We have here a large pale Chiton, which is said to be poisonous." Ladies who are not good sailors, and are fond of trying new preventives against sea-sickness, may (if they can) swallow raw Chitons, and

so imitate the Iceland fishermen, who pretend that the "sea bugs" are an effectual remedy against this malady, and also that they quench thirst. Perchance the deglutition of these strange bolusus might by anticipating the evil rob a sea-passage of its horrors.—JEFFREYS, *British Conchology.*

Section I.—*Chitones Regulares.*

Head- and tail-plates similarly articulated.

A. *Leptoidea.*

Insertion-plates obsolete or, if present, unslit.

(*Extinct Forms.*)

The secondary and tertiary Chitons all belong to recent genera. The following are all palæozoic. A large number of the fossils described as Chitons (for instance *Sulcochiton Grayi*, Ryckholt) are not mollusks; many of them being valves of Balani or fragments of isopod crustaceans.

HELMINTHOCHITON, Salter. Shell elongated, regular; mucro regular, subcentral; terminal valves not sinuated; apophyses unknown. *Distr.*—2 sp. Silurian, Devonian; Europe. *C. Griffithii*, Salter (lxxxv, 58).

GRYPHOCHITON (Gray), Carpenter. Shell elongated; lateral laminæ none, suturals small, separated by a wide, simple sinus; mucro incurved like the beak of a Gryphæa; posteriorly and anteriorly strongly sinuated. *Distr.*—4 sp. Carboniferous; Belgium. *C. priscus*, Münster (lxxxv, 70).

CHONECHITON, Carpenter. Shell Leptoidal, the central valves like Gryphochiton, the last with posterior mucro, infundibuliform. *Distr.*—Carboniferous; Belgium. *C. viseticola*, Ryck. (lxxxv, 59).

PRISCOCHITON, Billings. Leptochiton, with posterior lamina excavated within. *Distr.*—L. Silurian; Canada. *C. Canadensis*, Billings (lxxxv, 64–66).

PTEROCHITON, Carpenter. Shell elongated, Leptoidal; valves laterally excavated, posteriorly acuminated; last valve regular, the mucro Ischnoidal; anterior valve (usually?) sinuated; apophyses large, sinus wide. *Distr.*—6 sp. Devon.; Ireland, Belgium, etc. *C. eburonicus*, Ryck. (lxxxv, 67).

LORICITES, Carp. Related to Lorica, from which it differs in the absence of laminæ of insertion. Fossil. Type, *C. concentricus*, Koninck.

PROBOLÆUM, Carpenter. Shell Leptoidal, elongated, largely projecting; central valve with the central area extending in front of the jugum; anterior valve sinuate, posterior valve (?). Among recent forms this comes nearest to Katherina, but the difference is still extremely great. *Distr.*—Devonian of Vilmar. *P. corrugatum*, Sandb.

CYMATOCHITON, Dall. Leptochiton with the valves thrown forward. Differs from Probolæum in the valves being transverse instead of squared, and in the terminal valves being regular instead of waved. *C. Loftusianus*, King (lxxxv, 68, 69).

Recent Forms.

LEPTOCHITON, Gray. (Lepidopleurus, Risso. Craspedochilus and Boreochiton, Sars.) Insertion-laminæ none; girdle or zone minutely sandy; sinus smooth, not laminated. Branchiæ short. *Distr.*—10 sp. Northern Seas, Kerguelen's Isl. Type, *L. asellus*, Lowe. *L. cancellatus*, Sowb. (lxxxv, 71). Only 2 out of the 25 species cited by Adams really belong here.

DESHAYESIELLA, Carpenter. Valves curved forwards; mucro planate; zone or girdle spiculose; insertion-plates none; sutural laminæ triangular, raised. *C. (Leptochiton) curvatus*, Cpr.

HANLEYIA, Gray. Anterior valve with an unslit insertion-plate; other valves destitute of the plates. *Distr.*—Mostly northern; one from deep waters, Gulf of Mexico. *C. debilis*, Gray.

HEMIARTHRUM, Carpenter. Insertion-plates present on all the valves, but entire without slits. *H. setulosum*, Carpenter.

MICROPLAX, H. Adams. Resembling Chitonellus externally; submerged laminæ unslit, entire, fused in an undistinguishable manner with the parts which usually constitute the sutural laminæ. *M. Grayi*, Ad. and Ang.

B. *Ischnoidea.*

Insertion-plates sharp, smooth, fissured; with eaves.

* *No pores on girdle.*

TRACHYDERMON, Cpr. (Lepidopleurus sp., Auct. Craspedochilus, Sars.) Insertion-laminæ acute, smooth; valves within and without exactly like Ischnochiton; zone or girdle not poriferous, granulated by very minute scales. Branchiæ short. This name was originally proposed as a subgenus of Ischnochiton to include Gray's second section, "mantle-scales minute, granular." In all other conchological characters the group accords with that genus, but the animal differs in having the gills either entirely posterior or reaching forward from the tail only to about the middle of the foot, while in Ischnochiton and Chiton they travel to its anterior extremity. These characters indicate a transition between the Ischnoid and Leptoid Chitons by means of Trachydermon and Tonicella. *Distr.*—Chiefly northern. *C. ruber*, Lowe (lxxxv, 72).

TRACHYRADSIA, Cpr. Central valve doubly or many-cleft. *C. fulgetrum*, Reeve.

CALLOCHITON, Gray. Laminæ broken up into very numerous teeth rising out of spongy eaves, and having a tendency to

become propped outside; sinus a mere wave in the united bodies of the sutural laminæ; mantle reticulated with peculiar bodies, the tips of which appear like diamond-shaped scales, and which are unlike the armature of any other Chiton. *C. lævis*, Mont. (lxxxv, 73).

STEREOCHITON, Cpr. Girdle coriaceous, sparsely downy. *S. castaneus*, Wood.

TONICELLA, Carpenter. Valves, mucro, laminæ and sinus usually as in Ischnochiton; zone as in Tonicia, coriaceous, smooth or nearly so. The genus Tonicia, Ads. and Gray, to which the species of Tonicella have often been referred, has pectinated insertion-plates and ambient gills like the typical Chitons, while Tonicella has sharp plates and short rows of gills. The two groups also differ in dentition. *Distr.*—Mostly Northern; Atlantic, California. *T. marmoreus*, Fabr.

SCHIZOPLAX, Dall. (Tonicia sp., H. and A. Adams.) Shell and zone like Tonicella; central valves with a median slit. Branchiæ subambient. *Distr.*—*S. Brandtii*, Midd. Alaska, Siberia.

LEPTOPLAX, Carpenter. Valves thin, smooth, partly immersed; insertion-laminæ acute, terminals few-fissured, but regular; sinus not dentate; mucro median. *C. coarctatus*, Sowb. (lxxxv, 74). May be considered a partially covered Tonicella.

CHÆTOPLEURA, Shuttleworth. (Acanthopleura, Gray.) Shell like Ischnochiton; insertion-plates regular, branching; middle valve with one, anterior and posterior with many slits; teeth sharp, normal; eaves moderate; sinus broad, or minute; girdle hairy. Gills encircling. *Distr.*—Several sp. *C. Peruvianus*, Lam. (lxxxv, 75).

MAUGERELLA, Cpr. Middle valve with two slits; eaves projecting; girdle with short, striated, shelly bristles. *C. conspicuus*, Carp.

SPONGIOCHITON, Carpenter. Valves partly immersed; laminæ acute, Ischnoid; sinus large, smooth; mucro median, planate; zone spongiferous, produced in front. May be considered a partially covered Chœtopleura. *C. productus*, Cpr.

ISCHNOCHITON, Gray. (Lepidopleurus, H. and A. Adams.) Shell thin; laminæ of insertion regular, acute, neither pectinate nor serrate; eaves (subgrundæ) large; sinus usually smooth; girdle squamose, the squamæ generally striate. Branchiæ elongated. *C. longicymba*, Blainv. (lxxxv, 76).

The main character of this group, which includes by far the largest number of species of any single group of Chitons, consists in the row of sharp, smooth insertion-teeth, surrounded by more or less projecting eaves, and in the scaly girdle.

Dr. Carpenter has proposed the following eight subgenera, which I retain as sections:

ISCHNOCHITON (restricted). Scales transverse, flattened, somewhat imbricated, generally striated.

ISCHNORADSIA, Cpr. (ex Shuttlew.). Scales striated; central valves with many slits. *C. trifidus*, Cpr.

LEPIDOPLEURUS, Cpr. Scales solid, imbricated, smooth. *C. Mertensii*, Cpr.

LEPIDORADSIA, Cpr. Similar to the last, with many slits in central valves. *C. Australis*, Sowb.

STENOPLAX, Cpr. Body elongate; scales elongate, chaffy, striated, irregular and crowded. *C. limaciformis*, Sowb. (lxxxv, 96).

STENORADSIA, Cpr. Like Stenoplax, with numerous side-slits. *C. Magdalensis*, Hinds (lxxxv, 77).

ISCHNOPLAX, Cpr. Like Stenoplax, but with occasional large scales rising above the rest, and a multitude of short striated bristles; mucro raised, subposterior.

HETEROZONA, Carpenter. Body elongate; two kinds of rather solid, striated scales.

CALLISTOCHITON, Cpr. Insertion-plates regular, branching; middle valve with one, anterior and posterior with many slits; teeth excurved, plumate; eaves projecting, long; sinus broad, shallow, laminate; girdle narrow, with small scales; gills encircling.

* * *With girdle-pores.*

CALLISTOPLAX, Cpr. Shell as in Callistochiton, poriferous girdle naked. *C. retusus*, Sowb. (lxxxv, 78).

ANGASIA, Cpr. (Hanleyia, Ad. and Angas, not Gray.) Shell like Chætopleura, but the eaves small; girdle minutely squamulose-pilose, fasciculated at the sutures. *A. tetrica*, Cpr.

NEWCOMBIA, Cpr. Insertion-plates regular, branching; middle valve with one, anterior and posterior with many slits; teeth solid, not propped; eaves short; sinus rounded, simple; girdle fleshy, with long, hairy bristles.

CERATOZONA, Dall. Shell like Chætopleura, but the teeth raised, eaves short; girdle smooth, fasciculated around the sutures and margin. This differs from all other hairy or spiny Chitons, at all nearly related to it, in the mantle-ornaments not being inserted into sockets, but being extensions of its surface. *C. Guildingii*, Reeve (lxxxv, 79).

PALLOCHITON, Dall. Like Nuttallina; zone downy; central laminæ unifissured. This section unites in a form resembling Nuttallina, some of the features of Middendorfia, from which the girdle differs in being spongy and covered with soft hairs instead of short shelly bristles. *O. lanuginosus*, Cpr.

C. *Lophyroidea.*

Insertion-plates broad, pectinated, projecting backward.

CHITON, Lam. Girdle covered with distinct scales; anterior and posterior valves with many slits, middle valve with one; teeth blunt, serrate; eaves short, spongy; sinus squared, denticulate; gills ambient.

RADSIA, Gray. Teeth in middle valve two or more; differs also from Chiton in having side-slits. *C. Barnesii.*

TONICIA, Gray. Anterior and posterior valves with many slits, middle with one; teeth sharp, serrate; eaves short, spongy; sinus squared, denticulate; girdle smooth or downy; gills encircling. *C. elegans*, Fremb. (lxxxv, 80).

FANNETTIA, Dall. Insertion-plates regular, branching; middle valve with one, anterior and posterior with nine slits; teeth sharp, serrate, long; eaves very short, sinus squared, denticulate; girdle smooth, spreading; gills encircling.

EUDOXOCHITON, Shutt. Insertion-plates unfissured; teeth blunt, fimbriate; eaves short; sinus small, laminæ united; girdle hairy.

CRASPEDOCHITON, Shutt. Insertion-plates regular; middle valve with one slit, anterior with five, posterior with eight; girdle very minutely asperulate. The posterior valve is fimbriated in the middle. A doubtful group.

D. *Acanthoidea.*

Insertion-plates thrown forward.

* *Plates broad, pectinated.*

SCLEROCHITON, Cpr. Zone as in Enoplochiton; laminæ obtuse, pectinate; sinus waved, smooth. Most like Enoplochiton, from which it differs in the articulation of the tail-plate and the subcentral mucro.

** *Plates sharp, grooved outside.*

ACANTHOPLEURA, Guilding. (Lucia, Gould.) Anterior and posterior valves with many slits, middle with one; teeth blunt, grooved; eaves projecting, grooved; sinus large, waved; girdle with calcareous bristles. *C. spiniger*, Sowb. (lxxxvi, 94).

FRANCISIA, Carp. Valves partly immersed, planate; central laminæ with several slits; sinus lobed. Bears the same relation to Acanthopleura that Fannettia does to Tonicia, with the additional peculiarity of Radsioid nicks in the central valves. *C. spinosus*, Brug. (lxxxv, 81).

*** *Plates sharp, smooth.*

DINOPLAX, Carpenter. Armor heavy, alate; mucro not elevated, submedian; laminæ separate, acute, smooth; last valve extending forwards; sinus small; girdle coriaceous, spinulose in fascicles. *C. gigas*, Linn. (lxxxv, 88).

MIDDENDORFIA, Cpr. (Dawsonia, Cpr.) Armor and girdle as in Acanthopleura; laminæ acute, rugose exteriorly; the sinus planate, not laminated. *C. Polii*, Phil.

BEANELLA, Dall. (Beania, Cpr., not Johnstone.) Armor a girdle intermediate between Acanthopleura and Ischnochit mucro submedian; the laminæ acute; the girdle scaly, subspino scarcely imbricated. *C. Rissoi*, Cuming.

ARTHURIA, Carp. Armor thin; valves waved; mucro posteri produced; laminæ acute, smooth; last valve extending forwar sinus planate, laminate, smooth; girdle coriaceous, smooth downy. *C. filosus*, Cpr.

NUTTALLINA, Cpr. (Named in honor of Prof. Thomas Nutt a pioneer collector of Californian shells.) Shell elongated, val projecting anteriorly; mucro posterior, elevated; laminæ acu smooth, elongate; central valves bifissate; sinus not laminat planate; girdle spinose. Differs from Acanthopleura in smoothness of the sharp teeth, in their great length and Radsi slitting; in the thrown-back mucro, which often projects beyo the margin; in the throwing forward of the rest of the shell, in Katherina, and in the deep spongy flat sinus which interru the sutural laminæ. *C. scabra*, Reeve (lxxxvi, 85).

PHACELLOPLEURA, Guild. Posterior valve thrown forwa having six or more slits; anterior valve with five slits; middle, slit; teeth very long, sharp, smooth; eaves very short; sin narrow, laminæ separated; girdle thin, downy, wide, with sutu pores. *C. porphyriticus*, Reeve.

Section II.—*Chitones irregulares.*

Tail-plate abnormal or with a sinus behind.

E. *Schizoidea.*

Tail-valve fissured.

LORICA, H. and A. Adams. Insertion-plates regular, poster valve slit between two ridges; anterior valve with many sli middle with one; teeth blunt, rugose; eaves moderate; sin narrow, girdle slit behind, smooth, scaly. *C. cimolius* (lxxxvi, 8

AULOCHITON (Shuttl.), Cpr. Mucro posterior, slightly sinua sinus lobed; girdle covered with small scales, produced in fro *C. Angasi*, H. Ad.

SCHIZOCHITON, Gray. Insertion-plates straight forward, de slit, slits many in anterior valve, one to two in middle, few posterior valve; teeth sharp, long; eaves small; sinus narro very deep; girdle slit behind, covered with minute spiculæ. *incisus.*

F. *Placiphoroidea.*

Tail-valve unslit, internally ridged, mucro nearly terminal.

ENOPLOCHITON, Gray. Insertion-plates straight forward, behind; anterior valve with many slits, middle with one, posteri with none; teeth serrate; eaves moderate; sinus deep, lobe girdle large, with separate scales, and bristles between. *Coquimbensis*, Fremb. (lxxxvi, 87).

ONITHOCHITON, Gray. Insertion-plates regular, flat behind; anterior valve with many slits, middle with one, posterior with none; teeth serrate; eaves deeply furrowed; sinus moderate, lobed; girdle with chaffy hairs. *C. Lyellii*, Sowb. (lxxxvi, 82).

PLACIPHORA, Gray. Insertion-plates regular, ribbed behind; anterior valve with many slits, middle with one, posterior with none; teeth slightly propped; eaves small; sinus small; girdle hairy, with regular pore-tufts. *C. Carmichaelis*, Gray.

FREMBLYA, H. Adams. Valves regular, ribbed behind; the middle with one, anterior with many, posterior with no slits; teeth excurved; eaves small; sinus broad, shallow; girdle hairy, with regular pore-tufts. Distinguished by its excurved teeth. *C. Collei*, H. Ad.

EUPLACIPHORA, Shutt. Sinus wide, planate; girdle set with bristles, not fasciculated.

GUILDINGIA, Cpr. Valves partly immersed; girdle emarginate behind. *C. petholatus*, Sowb. (lxxxvi, 89).

G. *Mopaloidea.*

Tail-valve with posterior sinus and one slit on each side.

MOPALIA, Gray. Shell regular; laminæ lengthened; anterior valve with six or more slits, the others with a single slit; last valve sinuate behind; sinus narrow; mucro median, depressed; sutures indented; girdle wide, bristly, sometimes fissured behind, sometimes projecting anteriorly. *C. Blainvillei*, Brod. (lxxxvi, 90).

PLACIPHORELLA, Cpr. The hairs or part of them issuing in fasciculi from sutural pores. *C. velata*, Cpr.

KATHERINA, Gray. Armor small; girdle smooth, much expanded in the sutures; laminæ greatly projecting anteriorly, the posterior valve lobate; sinus deep, spongy. Branchiæ encircling. *Distr.*—*C. tunicatus*, Wood (lxxxvi, 91). W. Coast America, California to Alaska, Kamtchatka.

ACANTHOCHITON, Leach. Insertion-plates thrown forward, laminated; anterior valve with five slits, middle and posterior valves each one; teeth long, sharp, smooth; eaves small; gills median; sinus deep, broad, spongy; girdle hairy, with long, fasciculated spiculæ. *C. fascicularis*, Auct.

MACANDRELLUS, Cpr. Valves partly immersed; mucro Ischnoidal; posterior lamina rugosely lobate; lateral area depressed. *C. plumens*, Cpr.

STECTOPLAX, Cpr. Valves two-thirds immersed.

NOTOPLAX, H. Adams. Tail-plate crenate behind; first valve with five, last with two, middle with one slit; teeth crenate, sharp, smooth; eaves minute; sinus deep, narrow; gills crowded with spicules, and with sutural pores.

H. *Cryptoidea.*

With double sutural laminæ.

CRYPTOCONCHUS, Guilding. Insertion-plates regular, variable behind; anterior valve with five slits, middle one, posterior irregular; teeth very long, smooth; eaves minute; sinus deep, arched; girdle smooth, tufted; valves nearly covered; gills one-third. *C. porosus.*

AMICULA, Gray. (Symmetrogephyrus, Midd. Stimpsoniella, Cpr.) Shell regular; exposed valves small, mucronate or subcordate; posterior sutural laminæ large; girdle more or less pilose, sometimes poriferous. Branchiæ median in the typical group. *C. Pallasii*, Midd. (lxxxvi, 92).

CHLAMYDOCHITON, Dall. Branchiæ encircling. The Amiculæ are provided with pores bearing fasciculi of bristles of a soft or horny character, and which, while often irregularly disposed or even almost entirely absent (in particular individuals), have a tendency to arrange themselves in two rows on each side of the median line, one row behind the exposed point of the valve, and another near its submerged lateral posterior angle, on each side. The mantle is also provided with a coating of fine, chaffy, deciduous scales. *C. amiculatus*, Pallas (lxxxvi, 93).

CRYPTOCHITON, Midd. and Gray. Valves entirely immersed in the girdle, which is minutely fasciculately pilose. Branchiæ encircling. *C. Stelleri*, Midd. (lxxxv, 83) is the largest of the Chitons, attaining a length of eight inches. The valves are entirely covered, so that their outline even is not indicated in fresh specimens, although plainly marked in those which have been dried. The Aleutians and Indians eat the foot and softer parts, in the raw state.

I. *Chitonelloidea.*

Tail-plate funnel-shaped, laminæ thrown forward.

CHITONELLUS, Blainville.

Insertion-plates very sagittate; slits in anterior valve 5, in middle 0–1, in posterior none; teeth very short, except at sutures; eaves distinct; sinus very deep and narrow; girdle crowded with bristles, no tufts; gills posterior. The species enjoy considerable powers of locomotion compared with other groups of the family. *C. fasciatus*, Quoy (lxxxv, 95).

CRYPTOPLAX, Gray. Middle valve without slits; girdle with crowded bristles, tufted.

CHONEPLAX, Cpr. Animal creeping, rather long; exposed valves small, contiguous; last one infundibuliform; mucro recurved, terminal; laminæ as in Katherina, but obsoletely slit; girdle as in Acanthochiton. *C. striatus*, Sowb. (lxxxv, 84).

CHITONISUS, Cpr. Girdle not poriferous. Based on *C. striatus*

and *C. strigatus*, Sowb., which are figured as without pores. In the former the valves are separated, in the latter they touch. The species need examination to confirm the accuracy of the figures, but it is probable that there are both poriferous and not poriferous.

Family NEOMENIIDÆ.

The characters of the family are derived from those of the principal genus. It is one of the lowest forms of mollusks, being without many of the organs typifying its order.

Neomenia gorgoniophila, Kowalewsky, creeps somewhat like Nemertes; it sometimes leaves the water, and advances on a dry surface until it dies by exsiccation. When stopped by an obstacle, it creeps backwards.

Neomenia, Tullberg.

Syn.—Vermiculus, Dalyell. Solenopus, Sars.

Distr.—5 sp. Norway, Mediterranean.

Sexes united; no tentacula, no eyes, no radula, no jaw, no shell; body more or less worm-shaped; foot long, narrow, entirely hidden by the mantle; gills at the hinder end of the animal, retractile; heart rather developed; body-cavity entirely filled with entrails; generative organs situated along the back, above the stomach and intestine; nervous system composed mainly of a suprapharyngeal circle, with cerebral ganglion, and of two pedal ganglions.

Proneomenia, Hubrecht.

Distr.—*P. Sluiteri*, Hubrecht. Nova Zembla.

Body cylindric, calcareous spicula of the epidermis enveloped by a very thick cuticle. A small radula, and distinct salivary glands. A gland near the vent, at the hinder end of the animal, is considered to be the organ of Bojanus. The lateral glands described by Tullberg are probably oviducts. The glands on both sides of the vent seem to be analogous to a byssal gland.

Order NUCLEOBRANCHIATA.

Pelagic animals swimming by means of fin-like lobes of the foot; with or without shells, the latter being transparent, glassy.

The respiratory and digestive organs form a sort of nucleus on the posterior part of the back, whence the name.

The abdomen, or visceral mass, is small, whilst the anterior part of the body (or cephalo-thorax, M. Edwards) is enormously developed. The proboscis is large and cylindrical, and the tongue armed with recurved spines. The alimentary canal of

Firola is bent up at a right-angle posteriorly on the dorsal side; in Atlanta it is recurved, and ends in the branchial chamber. The heart is prosobranchiate, although in Firola the auricle is rather above than in front of the ventricle, owing to the small amount of the dorsal flexure.

The nucleobranchs, and especially those without shells, "afford the most complete ocular demonstration of the truth of Milne Edwards' views with regard to the nature of the circulation in the Mollusca. Their transparency allows the blood-corpuscles to be seen floating in the general cavity of the body—between the viscera and the outer integument—and drifting backwards to the heart; having reached the wall of the auricle they make their way through its meshes as they best can, sometimes getting entangled therein, if the force of the heart has become feeble. From the auricle they may be followed to the ventricle, and thence to the aorta and pedal artery, through whose open ends they pour into the tissues of the head and fin."—HUXLEY.

Such delicate and transparent creatures would hardly seem to need any special breathing organ, and, in fact, it is present or absent in species of the same genus, and even in specimens of the same species. Carinaria has fully-formed branchiæ; in Atlanta they are sometimes distinct, and wanting in others; in Firoloides they are only indicated by a ciliated subspiral band. The larvæ are furnished with a shell, and with ciliated vela.—GEGENBAUER.

The nucleobranchs are diœcious; some individuals (of Firola) have a leaf-like appendage, others a long, slender egg-tube depending from the oviduct, and regularly annulated. The larvæ are furnished with a shell and with ciliated vela.—GEGENBAUER.

The nervous system is remarkable for the wide separation of the centres. The buccal ganglia are situated considerably in front of the cephalic, and the pedal ganglia are far behind, so that the commissures which unite them are nearly parallel with the œsophagus. The branchial ganglia are at the posterior extremity of the body, as in the bivalves. The eyes are hour-glass shaped, and very perfectly organized; the auditory vesicles are placed behind, and connected with the cephalic ganglia; they each contain a round otolite, which sometimes seems to oscillate.—HUXLEY.

FAMILY FIROLIDÆ.

Animal elongated, cylindrical, translucent, furnished with a ventral fin, and a tail-fin used in swimming; gill exposed on the posterior part of the back. No shell.

The genus Sagitta, Q. and G., sometimes referred to this family, is an articulate animal.—HUXLEY.

FIROLA, Peron and Lesueur.

Syn.—Pterotrachæa, Forsk. Anops, d'Orb.

Distr.—14 sp. Atlantic, Mediterranean, Pacific. *F. Quoyana*, d'Orb. (lxxxvi, 97).

Animal fusiform, elongated, with a long, slender, proboscidiform head; fin narrowed at the base, usually furnished with a small sucker; tail elongated, keeled, sometimes pinnate; nucleus prominent; branchial processes numerous, conical, slender; tentacles very short and conical; eyes black and distinct, protected by a rudimentary eyelid; lingual ribbon oblong. The female Firolæ have a long moniliform oviduct. *Anops Peronii*, d'Orbigny, described and figured as having no head (!), was probably a mutilated Firola. "Such specimens are very common, and seem just as lively as the rest."—HUXLEY.

FIROLOIDES, Lesueur. (Cerophora, d'Orbigny.) Body cylindrical; head tapering, furnished with two slender tentacles; nucleus at the posterior extremity of the body, with or without small branchial filaments; egg-tube regularly annulated; tail-fin small and slender, ventral fin with or without a sucker. *Distr.*—6 sp. Atlantic, Mediterranean. *F. Gaimardi*, Orb. (lxxxvi, 98).

FAMILY CARINARIIDÆ.

Animal with pedunculated nucleus, covered by a glassy conical shell, from the margin of which project the branchiæ. Dentition (xii, 42).

CARINARIA, Lam.

Etym.—*Carina*, a keel. *Syn.*—Tithyonia, Cavolini.

Distr.—8 sp. Tropical and subtropical seas. Fossil, 1 sp. Miocene; Turin. *C. fragilis*, Bory (lxxxvi, 99). *C. vitrea*, Lam. (lxxxvi, 100).

Shell hyaline, symmetrical, limpet-shaped, with a posterior, subspiral apex and a fimbriated dorsal keel; nucleus minute, dextrally spiral.

Animal (lxxxvi, 99) large, translucent, granulated; head thick, cylindrical; lingual ribbon triangular, teeth increasing rapidly in size, from the front backwards; tentacles long and slender, eyes near their base; ventral fin rounded, broadly attached, with a small marginal sucker; tail large, laterally compressed; nucleus pedunculated, covered by the shell, gills numerous, pinnate, projecting from beneath the shell.

They feed on small Acalephæ, and probably on the Pteropoda; Mr. Wilton found in the stomach of a Carinaria two fragments of quartz rock, weighing together nearly three grains. The sucker on the fin of this and the preceding genus was formerly supposed to be characteristic of the male, but it has recently been found well-developed on female individuals. Mr. Arthur

Adams, in the delightful narrative of the "Voyage of the Samarang," says of these animals:

"When fresh taken, I have seen both the Carinariæ and Atlantæ swim with their bodies in every position, on their sides, on their backs, and with the foot downwards. The Carinariæ are swift and rapid in their movements, and dart forwards by a continuous effort, moving their foot and caudal appendage from side to side, as a powerful natatory organ, and do not progress by sudden jerks, like the Atlanta and Hyalæa. The true analogue of the foot of gastropods in Atlanta and Carinaria is the sucking disk, but its use is circumscribed to that of enabling the animal to anchor itself temporarily to floating bodies when fatigued. The shell of Carinaria covers only a small portion of the body, defending the more delicate organs, and in this we see a wise provision for permitting these pelagic mollusks to move freely about, without being encumbered with a dense, heavy skeleton."

CARDIAPODA, d'Orbigny.

Etym.—*Cardia*, heart, *pous*, foot.

Syn.—Carinaroides, Eyd. and Souleyet.

Distr.—5 sp. Atlantic. *C. placenta*, Eyd. (lxxxvi, 1–3).

Shell minute, cartilaginous; peristome expanded and bilobed in front, enveloping the spire behind.

Animal like Carinaria, tail simple, acuminate.

FAMILY ATLANTIDÆ.

Animal furnished with a well-developed shell, into which it can retire; gills contained in a dorsal mantle-cavity; lingual teeth similar to Carinaria. Dentition (xii, 41).

Shell symmetrical, discoidal, sometimes closed by an operculum.

ATLANTA, Lesueur.

Syn.—Steira, Esch.

Distr.—18 sp. Warmer parts of the Atlantic, Canary Islands. *A. turriculata*, d'Orb. (lxxxv, 4, 5). Fossil, 1 sp. Tertiary: San Domingo.

Shell minute, glassy, compressed and prominently keeled; nucleus dextrally spiral; aperture narrow, deeply notched at the keel. Operculum ovate, pointed, lamellar, with a minute, apical, dextrally spiral nucleus.

Animal three-lobed; head large, subcylindrical; tentacles conical, with conspicuous eyes behind them; ventral fin flattened, fan-shaped, furnished with a small, fringed sucker; tail pointed, operculigerous.

"The Atlanta," writes Mr. Arthur Adams, "is quite a sprightly little mollusk, probing every object within its reach, by means

of its elongated trunk, twisting its body about, and swimming in every direction by the lateral movements of its vertical, dilated foot. I have frequently seen them descend to the bottom of the glass vessel in which they were kept, fix themselves there in the manner of a leech, by their sucking disk, and carefully examine the nature of their prison-house by protruding the front portion of the foot in every direction."

They swim shell downwards, with sudden jerks, by means of their compressed and fin-like foot.

OXYGYRUS, Benson.

Syn.—Ladas, Cantraine. Helicophlegma, d'Orb.

Distr.—4 sp. Atlantic, Mediterranean. *O. Keraudrenii*, Rang (lxxxvi, 6, 7).

Shell milky, narrowly umbilicated on both sides; nucleus not visible; back rounded, keeled only near the aperture; body-whorl, near the aperture, and keel cartilaginous; no apertural slit. Operculum trigonal, lamellar.

SUBCLASS OPISTHOBRANCHIATA.

Branchiæ exposed, or protected by a fold of the mantle and situated at the posterior centre of the back, and never in a cervical cavity. Sexes united. Some have an internal or external spiral or patelliform shell, testaceous or membranous, others are without shell.

The mollusks of this subclass may be termed sea-slugs, since the shell, when it exists, is usually small and thin, and wholly or partially concealed by the animal. When alarmed or removed from their native element, they retract their gills and tentacles, and present such a questionable shape that the inexperienced naturalist will be likely enough to return them, with the refuse of the dredge, into the sea. Their internal structure presents many points of interest; in some the gizzard is armed with horny spines, or large shelly plates; in others the stomach is extremely complicated, its ramifications and those of the liver being prolonged into the papillæ, which are said to be branches of the respiratory organ. The tongue is armed, but the number and arrangement of the lingual teeth is exceedingly variable, even in the same family; usually the dental membrane is broad and short, with many similar teeth in each row.

The alimentary canal terminates more in the rear of the body than in the other univalve shell-fish. The gills are behind the heart, and the auricle behind the ventricle; conditions which characterize the embryonic state of the mollusca generally.

Comparatively little is known of the geographical distribution of these animals; they have been found wherever the requisite search has been made, and are probably much more numerous

than at present estimated. Considerable additions, however, have been made to our knowledge on this subject by the researches of Kelaart in Ceylon and A. Adams in the Chinese seas. The shell-bearing genera flourished in the period when the secondary strata were deposited. The living species are chiefly animal-feeders, preying on other shell-fish and on zoophytes.

ORDER TECTIBRANCHIATA.

Animal usually provided with a shell, both in the larval and adult state; branchiæ covered by the shell or mantle.

FAMILY PHILINIDÆ.

Shell usually present, sometimes wanting, internal, bulliform, but slightly spiral, usually not forming a single whorl; it is concealed under the lateral margins of the foot.

Teeth, central none; lateral one or two, large, hooked. Cephalic disk oblong or subquadrate, without tentacular lobes; eyes none, or, if present, sessile on the head; mantle covering and concealing the shell; foot not produced posteriorly, the sides dilated, thick and fleshy; gizzard armed with calcareous plates.

PHILINE, Ascanias.

Syn.—Bullæa, Lam. Megistoma, Gabb. Utriculopsis, Sars.

Distr.—20 sp. West Indies, Boreal Atlantic, Mediterranean, East Indies. Fossil, 7 sp. Eocene. *P. aperta*, Linn. (lxxxvii, 14, 15).

Shell internal, white, translucent, oval, slightly convoluted, spire rudimentary.

Animal pale, slug-like; mantle investing the shell; head oblong; eyeless; foot broad; lateral lobes large, but not enveloping; tongue with two or four series of sickle-shaped uncini; gizzard with three longitudinal shelly plates. Egg-capsules ovate, in single series on a long spiral thread; fry with a ciliated head-veil and an operculated, spiral shell.—LOVÉN.

The animal is blind, like most creatures that seek their food by burrowing. They frequent mud-flats and slimy banks at the entrances of rivers, which they perforate near the surface, and probe with their flattened heads for the small bivalves which constitute their prey; these they seize and swallow entire, breaking their shells by means of their testaceous, muscular gizzards.

CHELIDONURA, A. Adams. (Hirundella, Gray.) Shell concealed; outer lip produced posteriorly into a spur; columellar border inflected. Animal with enveloping side-lobes; mantle with two appendages behind, like the lateral processes of Hyalæa. *P. hirundinaria*, Quoy (lxxxvii, 16, 17).

PHANEROPTHALMUS, A. Ad.

Syn.—Xanthonella, Gray.

Distr.—*P. luteus*, Quoy (lxxxvii, 18, 19).

Shell oval, convex, pointed behind, columella-margin with a curved process. Animal long, cylindrical, head with short tentacular lobes, eyes in middle of disk, lateral lobes enveloping.

CRYPTOPHTHALMUS, Ehrenberg.

Distr.—*C. olivaceus*, Ehr. (lxxxvii, 20). Red Sea.

Shell scarcely convolute, fragile, oval, convex, without spire or columella.

Animal semicylindrical, head with short tentacular lobes, eyes small, concealed under the lateral margins of the head, mantle and lateral lobes enveloping the shell.

PHILINOPSIS, Pease, 1860.

Distr.—2 sp. Sandwich Isles. *P. speciosa*, Pease.

Shell white, fragile, pellucid, with a curved callous apex. Head-disk large, oblong-oval or triangular, not extending in advance of the foot; body truncated behind, and the truncation surrounded by an undulated or crenated crest; eyes not visible; mouth proboscidiform between cephalic disk and foot, with or without one pair of tentacles on sides of the mouth; foot large, rounded and reflected at the sides; branchial plume near the posterior end of the body, and curving around between the truncated end of the foot.

VOLVATELLA, Pease.

Distr.—*V. fragilis*, Pease. Sandwich Islands.

Shell convolute, subpyriform; aperture wide anteriorly, contracted posteriorly and produced, forming a circular aperture.

Animal. Mantle concealed; cephalic disk quadrate; tentacular lobes produced from the corners; anal aperture posterior; foot small and triangular.

LINTERIA, A. Adams.

Syn.—Smaragdinella, A. Ad. Glauconella, Gray.

Example.—*L. viridis*, Rang (lxxxvii, 21).

Shell oval, depressed, slightly spiral, greenish; aperture very large, canaliculated behind; inner lip with a spiral spoon-shaped process.

Animal partially investing the shell; eyes sessile on the middle of the frontal disk; mantle included within the shell, ending posteriorly in a thickened lobe; foot with the side-lobes free, not united to the head, enlarged in the form of wings which unite behind and cover a portion of the shell.

Amphibious, living on moist rocks within reach of the spray,

and on rocks weeping fresh water near the sea-shore. Both animal and shell are of a glaucous green color.

NONA, H. and A. Adams. Shell white, fragile; outer lip produced into a wing behind. *L. Algiræ* (lxxxvii, 22).

SCAPHANDER, Montfort.

Etym.—*Scaphe*, boat, *aner*, man.

Distr.—13 sp. United States, Norway, Britain, Mediterranean on sandy ground, 50 fathoms. Fossil, 8 sp. Eocene—. *S. lignarius*, Linn. (lxxxvii, 23).

Shell oblong, convolute; spirally striated; aperture much expanded in front; spire concealed; epidermis thick; lingual teeth 1·0·1, crested.

Animal with a large oblong head, destitute of eyes; foot short and broad; lateral lobes reflected, but not enveloping the shell; gizzard with two large trigonal plates and a small narrow transverse plate. It feeds on *Dentalium entale*.

AGLAIA, Renier.

Syn.—Acera, Cuvier. Eidothea, Risso. Doridium, Meckel.

Distr.—3 sp. South Europe. *D. membranaceum*, Meck. Mediterranean.

Animal oblong, truncated behind, the angles produced and dilated or filiform; head ovate-oblong, retuse in front; side-lobes expanded, wing-like; mantle investing a rudimentary, membranous shell.

GASTROPTERON, Meckel.

Distr.—*G. Meckelii*, Bl. (lxxxvii, 24). Mediterranean.

Animal oval, with side-lobes developed into wing-like expansions, meeting and uniting behind; cephalic disk triangular, obtuse in front, pointed behind, eyes centrally immersed; lingual teeth 5·1·5; mantle (?), branchial plume exposed on the right side; reproductive orifice in front of the gill, excretory opening behind it. Shell almost microscopic.

[ATLAS, Lesueur.

Referred to this family by several systematists, is a larval creature, and not of a mollusk.—MACDONALD.]

FAMILY TORNATELLIDÆ.

Animal generally perfectly retractile, but mostly of large size when expanded; foot thick, reflexed on the sides; head broad, very often forming a flat disk, with or without other appendages; tentacles broad, thick, united at base; eyes sessile near the base. Dentition, laterals numerous, uniform, in diverging cross series, rachidian teeth wanting (xiii, 68).

Operculum, when present, horny, ovate, narrow, composed of few whorls.

Shell spiral, ovate, convolute or involute, spire more or less elevated, surface mostly spirally punctated, aperture usually high and narrow, truncate or roundish in front, columella solid.

The genera and species referred to this family are mostly fossil. The arrangement here followed is that of Dr. Stoliczka (*Pal. Indica*, ii, 398), being a modification of the classification of Dr. F. B. Meek (*Am. Jour. Sci.*, xxxv, 89, 1863).

SUBFAMILY *TORNATELLINÆ*.

Shell ovate, aperture anteriorly rounded, sometimes broadly effuse, outer lip sharpened at the margin, columellar lip twisted and often plicated in front. The recent species operculated.

ACTÆONINA, d'Orb.

Syn.—Trochactæonina, Meek. Orthostoma, Desh.

Distr.—30 sp. Carboniferous to Eocene. *A. Lorieriana*, d'Orb. (lxxxviii, 46).

Shell oval, elongated, conical or fusiform, with revolving punctated striæ; aperture long and narrow, widened in front, entire; lip sharp; columella thickened, but without plications.

EUCONACTÆON, Meek, 1863. (Conactæon, Meek, 1863.) Shell thin, obconic, gradually tapering anteriorly, spire either immersed or elevated, aperture very long, equally narrow all through, anteriorly rounded, columella slightly thickened, smooth. *Distr.*—Jurassic. *A. concava*, d'Orb. (lxxxviii, 47).

CYLINDRITES, Morr. and Lyc. (Goniocylindrites, Meek.) Shell subcylindrical or ovate, smooth, spire sunken or moderately elevated, aperture narrow, very high, anteriorly rounded, subeffuse, columella twisted anteriorly into a distinctly conspicuous fold. *Distr.*—Triassic and Jurassic. *A. cuspidatus*, Morris (lxxxviii, 48).

CYLINDROBULLINA, von Ammon, 1878. Shell small, with elevated, scalariform spire; columella with a slight fold. Triassic to Liassic. *A. fragilis*, Dunker.

TORNATINA, A. Ad.

Distr.—24 sp. West Indies, United States, Mediterranean, Philippines, China, Australia. On sandy bottoms, ranging to 35 fathoms.—ADAMS. Fossil, 13 sp. Tertiary. *T. coarctata*, A. Ad. (lxxxvii, 25).

Shell cylindrical or fusiform, spire conspicuous, apex sinistral, suture channeled, columella callous, 1-plaited.

Animal with a broad, trigonal head, rounded in front; tentacular lobes triangular, with eyes at their outer bases; foot short, truncated in front.

MYONIA, A. Ad., 1860.

Distr.—M. Japonica, A. Ad. Japan.

Shell ovate, turreted; white, thin, with slightly convex, spirally sulcated whorls; aperture oblong, a little produced anteriorly; inner lip with an oblique fold.

LEUCOTINA, A. Ad. Last whorl ventricose, minutely punctate. *M. Niphonensis*, A. Ad. Japan.

TORNATELLA, Lam.

Syn.—Actæon, Montf. (not Oken). Dactylus, Schum. Myosota, Gray.

Distr.—22 sp. United States, Britain, Senegal, Red Sea, Philippines, Japan, Peru. Fossil, numerous. Trias to Lias—; North America, Europe, South India. *T. fasciata*, Lam. (lxxxvii, 26).

Shell solid, ovate, with a conical, many-whorled spire, spirally grooved or punctate-striate; aperture long, narrow, rounded in front; outer lip sharp; columella with a strong, tortuous fold. Operculum horny, elliptical, lamellar.

Animal white; head truncated and slightly notched in front, furnished posteriorly with recumbent tentacular lobes, and small eyes near their inner bases; foot oblong, lateral lobes slightly reflected on the shell. Lingual teeth 12·12, similar, with long simple hooks.

RICTAXIS, Dall. Shell like Actæon, but with the columella projecting beyond the line of the anterior margin, forming a small tooth-like projection, or truncate obliquely. *T. puncto-cælata*, Cpr. (lxxxvii, 28). California.

SOLIDULA, Fischer, 1807. (? Buccinulus, Plancus. Tornatellæa, Conrad.) Shell thick, columella with two plaits. *A. solidula*, Lam. (lxxxvii, 27).

NUCLEOPSIS, Conrad. Uncharacterized. *A. subdivaricatus*, Conr. (lxxxviii, 49).

ACTÆONIDEA, Gabb. Oval, elongate; aperture narrow, outer lip simple, columella with one large transverse fold in the middle, and truncated in advance; surface ornamented by revolving ribs. *A. oryza*, Gabb (lxxxviii, 50). Tertiary; W. I. Form of Cylindrites, sculpture of Actæon.

TRIPTYCHA, Müller, 1859.

Distr.—T. Limnæiformis, Müller. Cret.; Europe.

Ovate, almost perfectly smooth, aperture rounded anteriorly, outer lip sharp, inner lip with three folds, of which the middle one is largest. Only one fossil species; perhaps a Marinula.

TROCHACTÆON, Meek.

Syn.—Actæonella, d'Orb. (in part). Spiractæon, Meek.

Example.—T. Reneauxiana, d'Orb. (lxxxviii, 51).

Shell turbinate, more or less involute, last whorl usually higher than the spire, with a flattened narrow solid edge along the suture; aperture semieffuse, anteriorly rounded, inner lip thickened, especially in front, and provided with three oblique folds.

GLOBICONCHA, d'Orb.

Distr.—6 sp. Cretaceous; France. *G. coniformis*, Römer (lxxxviii, 52). *G. Fleuriausa*, d'Orb. (lxxxviii, 53).

Shell globular-conic, spire short, or involute; aperture narrow, crescent-shaped; margin acute; columella not thickened or plaited.

TYLOSTOMA, Sharpe, 1849.

Etym.—*Tulos*, a callosity, *stoma*, mouth.

Distr.—4 sp. L. Cretaceous rocks; Portugal. *T. torrubiæ*, Sharpe (lxxxviii, 54).

Shell ventricose, smooth or punctate-striate, spire moderate, aperture ovate-lunate, pointed above, rounded in front; outer lip periodically (once or twice in a whorl) thickened inside and expanded, rising slightly; inner lip callous, spread over body-whorl.

Stoliczka refers this genus to Naticidæ; its true affinities are difficult to ascertain.

VARIGERA, d'Orb. Shell with lateral varices. *T. Rochatiana*, d'Orb. (lxxxviii, 55). Cret.; France.

SUBFAMILY *RINGICULINÆ.*

The shells resemble Actæon except that they have the margins of the aperture strongly thickened and externally varicose, the canal is twisted or plaited, and always terminates anteriorly with a distinct fold, in front of which there is a groove or kind of canal in the thickened margin. The other genera proposed may well be considered subgenera of Ringicula.

RINGICULA, Desh.

Etym.—Diminutive of *ringens*, from *ringo*, to grin.

Syn.—Aptycha, Meek.

Distr.—75 sp., the recent ones in all warm seas. Fossil. Miocene—. *R. buccinea*, Desh. (lxxxvii, 29).

Shell minute, ventricose, with a small spire; aperture notched, columella callous, deeply plaited; outer lip thickened and reflected.

RINGINELLA, d'Orb. Shell oval, with revolving punctate striæ; aperture entire, without channel; outer lip strongly thickened; inner lip thickened, with anterior plications. Several cretaceous species. *R. clementina*, d'Orb. (lxxxviii, 57).

ERIPTYCHA, Meek. (Euptycha, Meek, preoccupied). Shell globose, aperture very narrow, one strong, often bifid anterior

fold in the inner lip, which is in the middle, flattened and projecting in the space of the aperture, being separated from the fold by a deep insinuation; the outer lip is generally somewhat produced anteriorly, the anterior canal being distinct. Cretaceous. *R. decurtata*, Sowb.

? STOMATODON, Seely, 1861. Described from a cast in the Cambridge Greensand. May be a Ringicula. *R. polita*, Seely.

CINULIA, Gray.

Distr.—25 sp. Cretaceous; Europe, United States. *C. globulosa*, Desh. (lxxxviii, 58).

Shell globose, spire short, surface spirally sulcated, aperture anteriorly produced, effuse, columella terminating with a single oblique and twisted fold.

OLIGOPTYCHA, Meek. Shell with spire much depressed and obtuse; outer lip smooth within, and very slightly sinuous at the base of the aperture; inner lip bearing a single, very prominent, nearly transverse plication or tooth at the base of the columella. *Actæon concinnus*, Hall and Meek (lxxxviii, 59).

AVELLANA, d'Orb. Shell globose, inner lip with two or three folds, one being anterior, often bipartite, placed at the termination of the columella, the other subanterior, separated from the former by a deep insinuation of the lip; there is generally a third one placed about the middle of the inner lip, and one or two posterior, much shorter ones, but these are not constant. *A. incrassata*, d'Orb. (lxxxviii, 60).

FAMILY CYLICHNIDÆ.

Shell external, spiral, more or less cylindrical, usually white. No operculum. Animal with depressed quadrangular head; truncated in front; bilobed behind; with eyes at the base of tentaculiform lobes; foot rather narrow, truncated in front. Teeth, central none, laterals 6·6, the inner large and hooked, the outer small and uniform, rarely wanting.

CYLICHNA, Lovén.

Syn.—Bullina, Risso.

Distr.—40 sp. Chiefly deep-water shells. United States, Greenland, Britain, Red Sea, Australia. Fossil. Triassic—. *C. arachis*, Quoy (lxxxvii, 30).

Shell strong, cylindrical, smooth or punctate-striate; spire minute or truncated; aperture narrow, rounded in front; columella callous, with one plait.

MNESTIA, H. and A. Adams. Shell oval, subcylindrical, banded, with revolving striæ; aperture narrow, prolonged into a point at both ends. *C. marmorata*, A. Ad. (lxxxvii, 31).

CYLICHNELLA, Gabb. Shell subcylindrical, spire sunken; mouth

narrow behind, widened in front; columella with two folds. *C. bidentatus*, d'Orb. (lxxxvii, 33). Tertiary; West Indies.

VOLVULA, A. Adams. Shell subcylindrical, attenuated to a point posteriorly, to which the narrow aperture extends; spire concealed; outer lip sharp; columella with an obsolete anterior plication. *C. acuminata*, Brug. (lxxxvii, 34).

ACTÆONELLA, d'Orb. (Volvulina, Stolicz.) Shell convolute, like Volvula, attenuated at both ends, aperture linear, inner lip anteriorly thickened and provided with three folds. The shells, which are as yet only known from cretaceous deposits, mostly closely resemble the recent Volvula, differing from it merely by the presence of three columellar folds on the anterior portion of the inner lip. *C. crassa*, d'Orb. (lxxxviii, 61). Cretaceous.

UTRICULUS, Brown.

Distr.—Northern. Several sp. *U. Cecillei*, Phil. (lxxxvii, 32).

Shell subcylindrical, with short spire, and thin epidermis; aperture narrow behind, wider in front; columella not plicated; outer lip thin.

Utriculus is regarded as a distinct genus by Jeffreys, differing from Cylichna by the tentacles being separate, the eyes distinct, the gizzard horny, and the shell having a visible spire with a mammillary apex.

DIAPHANA, Brown.

Syn.—Amphisphyra, Lovén.

Distr.—A few sp. Northern, U. S., Europe. *D. debilis*, Gould (lxxxvii, 35).

Shell thin, transparent, oval-globular; spire very short; aperture much widened anteriorly; columella a little sinuous; outer lip thin, sinuous, broadly rounded anteriorly.

Head-disk broad and short; tentacular lobes short, conical, lateral, wide apart; eyes immersed in their hind bases. Mantle-margin slightly thickened. Foot short, bilobed behind.

In this genus, as in Rissoella, Gray, the eyes are placed far back behind the head, so that in order to render the vision of the animal distinct, the shell is nearly transparent. The head of the animal is very short, and the tentacles wide and far apart.

FAMILY BULLIDÆ.

Shell spiral, ventricose, rather thick; maculated and banded in the typical genus, white in others; spire involute; external, but usually partly covered by the lateral lobes of the foot.

BULLA, Linn.

Distr.—50 sp. Universal. *B. ampulla*, Linn. (lxxxvii, 36). Fossil. Cretaceous—.

Shell oval-globular, smooth, spotted, marbled or zoned; spire

concave, umbilicated; aperture as long as the shell; inner margin without columella; outer lip trenchant.

Teeth, central one, laterals numerous, uniform, in an arched series. Animal partly investing, but not entirely covering the shell. Eyes conspicuous, sessile on the middle of the frontal disk. Mantle with the outer margin forming a thick, fleshy lobe. Foot with the lateral lobes moderate, and the hind-part not extending beyond the shell. The species of this genus inhabit sandy mud-flats, the slimy banks of river-mouths, and brackish places near the sea; at low-water some of them conceal themselves in the mud and under sea-weed, exuding large quantities of mucus to maintain the moisture of their skin; they feed on bivalves and other mollusca, which they swallow whole, reducing and crushing them afterwards by the calcareous plates of their powerful gizzard. The shells of Bulla, as restricted, are rather solid, smooth, and mottled and marbled like birds' eggs.

HAMINEA, Leach.

Example.—H. hydatis, Linn. (lxxxvii, 37, 38).

Shell oval-globular, spiral, ventricose, corneous, thin, covered by a slight, smooth epidermis; spire involute. May be distinguished from Bulla immediately by the want of color in the shell.

ATYS, Montfort.

Example.—A. naucum, Linn. (lxxxvii, 39).

Shell rather solid, uncolored, with a smooth epidermis; usually spirally striated; spire scarcely visible; aperture longer than the inner margin at both ends; columella with a single, more or less obsolete plication.

The animal is blind, or the eyes are subcutaneous.

LAONA, A. Ad. Semiovate, thin, striæ of growth lamellar, spire hidden; aperture with the inner lip arcuated, outer lip simple. *A. zonata*, A. Ad. Japan.

DINIA, H. and A. Adams. Shell ovoid, subtruncated behind, longitudinally striated; inner lip truncated anteriorly, terminating in a tooth-like projection. *A. dentifera*, Ad. (lxxxvii, 40).

SAO, H. and A. Adams. Shell pyriform, ventricose in front; umbilicated; apex involute; aperture narrow behind, wide in front; columellar lip reflected; outer lip thin, sinuous. *A. pyriformis* (lxxxvii, 41).

PHYSEMA, H. and A. Adams. Shell small, thin, hyaline, globular; umbilicated; very finely longitudinally striated; columella a little arcuated, reflected; outer lip thin, free behind, developed in the middle. *A. hiemalis*, Couth. (lxxxvii, 42).

ROXANIA, Leach. Shell ovoid, solid, perforate, decussately striate, transversely profoundly sulcate, the sulcations strongly punctate; aperture narrow, dilated in front; inner lip sharp,

truncate anteriorly; outer lip produced behind. *A. Cranchii*, Leach.

ALICULA, Ehrenberg, 1831. Shell subcylindrical, transversely striate. 3 sp. Japan. *A. translucens*, A. Ad. Japan.

LEUCONYX, H. and A. Ad., a supposed new genus of Bullidæ, is the spatulate hinge process of *Pholas costata*.

FAMILY APLUSTRIDÆ.

Teeth, central none; laterals numerous, uniform. Head with the frontal disk produced into large ear-like tentacular lobes folded over the back of the shell, and furnished with bifid labial appendages; eyes sessile at the inner bases of the tentacular lobes. Mantle with the inner margin thin and membranous, the outer forming a thick, fleshy lobe, curving round the spire of the shell; branchial plume long and single. Foot large and membranous, auriculate in front, rounded behind.

The shell has usually a short spire, the last whorl inflated, aperture anteriorly distinctly effuse, columella somewhat thickened, rarely twisted, but always anteriorly truncated.

APLUSTRUM, Schumacher.

Etym.—*Aplustre*, a ship's flag.

Distr—1 sp. Coral reefs, East Indies. *A. aplustre*, Linn. (lxxxvii, 43).

Shell oval, ventricose, highly colored; spire wide, depressed; aperture truncated in front; outer lip sharp.

Differs from Bullina by its smooth, somewhat thinner shell, more depressed spire, the columella being very thick, slightly twisted and truncated in front.

BULLINA, Fer.

Distr.—*B. lineata*, Wood (lxxxvii, 44).

Shell oval, rather solid, subumbilicated; spire distinct; whorls with revolving striæ; columella arcuated, obliquely truncated in front; outer lip crenelated.

KLEINELLA, A. Ad., 1860. Shell ovate, thin, umbilicated, cancellated, aperture produced anteriorly, inner lip not plicated. Resembles Actæon, but without columellar fold. Japan. *B. cancellaris*, A. Ad.

HYDATINA, Schum., 1817.

Distr.—Recent, several sp. Fossil. Jurassic—. *H. physis*, Linn. (lxxxvii, 45).

Shell ventricose, thin, smooth, not umbilicated, with a thin epidermis; usually banded; spire involute; columella arcuated, reflected.

BULLOPSIS, Conr. Like Hydatina with a depressed spire and inflated body-whorl, inner lip with two close folds. *B. cretacea*, Conr. Cretaceous; Mississippi.

ETALLONIA, Deshayes, 1864.

Etym.—Dedicated to M. Etallon, a French palæontologist.

Distr.—3 sp. Eocene; Paris basin, Valognes. *E. prisca*, Desh. (lxxxviii, 62).

Shell ovate, subfusiform, resembling certain small Mitres; spire short, conical, obtuse, few-whorled; aperture elongated, narrow, base entire, subemarginate; lip simple, acute, arched; columella thick, cylindrical, twisted in the middle to resemble an obtuse plait; acute anteriorly.

FAMILY LOPHOCERCIDÆ.

Shell spiral, very thin, subflexible, with epidermis.

Head with two ear-like tentacles; eyes sessile on the sides of the head; gill regular, pectinate; organs of generation close together in one tubercle; male organ on the right side of the nape near the tentacle. In Lophocercus, the body is covered with papillæ, and produced behind into a long, pointed tail; foot with the natatory appendages undivided, reflexed and partly covering the shell in front and united posteriorly.

LOPHOCERCUS, Krohn.

Syn.—Icarus, Forbes. Oxynoë, Raf.

Example.—*L. Sieboldi*, Krohn (lxxxix, 68, 70).

Shell like Bullæa; convoluted, thin, ovate, covered with epidermis, outer lip separated at the suture, posterior angle inflected and rounded.

Animal slender, papillose; tentacles 2, ear-shaped; eyes sessile on sides of head; side-lobes reflected and partly covering the shell, united behind; tail long and pointed.

VOLVATELLA, Pease. Shell resembling Lophocercus, but more convolute. Foot small, mantle concealed, vent posterior, eyes concealed in the fold of the sides of the head. *L. fragilis*, Pease.

AKERA, Müller.

Etym.—*Akeros*, hornless.

Distr.—7 sp. Greenland, Great Britain, Mediterranean, East Indies, New Zealand. *A. soluta*, Chemn. (lxxxix, 63). Fossil. Eocene.

Shell thin, flexible, globosely cylindrical, spire truncated, whorls channeled; aperture long, expanded and deeply sinuated in front, outer margin disunited at the suture; columella open, exposing the whorls.

Head-disk greatly elongated, wide and bifid anteriorly, and

narrowed posteriorly; the hind edge of the mantle is fimbriated and projects through the fissured suture of the shell; foot expanded, narrow and rounded anteriorly, broad and truncated posteriorly; by means of the extended lateral foot-lobes the animal swims with considerable facility.

CYLINDROBULLA, Fischer. Shell cylindrical, bulliform, thin, fragile, spire very short, suture slit; outer lip incurved, closing the aperture in the middle. *A. Beauii*, Fischer (lxxxix, 63).

LOBIGER, Krohn.

Distr.—4 sp. Atlantic, South Europe. *L. Philippii*, Krohn (lxxxix, 65, 66).

Shell oval, transparent, flexible, slightly convoluted; covered with epidermis.

Animal slender, papillose, with two flattened, oval tentacles, and minute sessile eyes on the sides of the head; shell exposed on the middle of the back, covering the plume-like gill; sides with two pairs of rounded, dilated lobes, or natatory appendages, foot linear, tail long and slender.

The four laterally expanded wing-like lobes easily distinguish this animal from Lophocercus.

FAMILY APLYSIIDÆ.

Shell wanting, or rudimentary and covered by the mantle, oblong, trigonal, or slightly convoluted.

Animal slug-like, with distinct head, tentacles, and eyes; foot long, drawn out into a tail behind; sides with extensive lobes, reflected over the back and shell; branchial plume concealed. Sexes united.

APLYSIA, Gmelin.

Etym.—*Aplysia* (from *a* and *pluo*), unwashable; the *Aplysia* of the Greek fisherman were sponges unfit for washing. Sea-hare. *Syn.*—Siphonotus (*geographicus*), Ad.

Distr.—48 sp. West Indies, Norway, Britain, Mediterranean, Mauritius, China. Fossil (?). Tertiary; Sicily. *A. depilans*, Linn. (lxxxix, 67, 71).

Shell oblong, convex, flexible, and translucent, with a posterior slightly incurved apex.

Animal oval, with a long neck and prominent back; head with four tentacles, dorsal pair ear-like with eyes at anterior lateral bases; mouth proboscidiform, with horny jaws, lingual teeth 13·1·13, hooked and serrated, about 30 rows; gizzard armed with horny spines; sides with ample lobes folding over the back, and capable of being used for swimming; gill in the middle of the back, covered by the shell and by a lobe of the mantle, which is folded posteriorly to form an excretory siphon.

The Sea-hares are mixed feeders, living chiefly on sea-weed, but also devouring animal substances; they inhabit the laminarian zone, and oviposit amongst the weed in spring, at which time they are frequently gregarious.—FORBES. They are perfectly harmless animals, and may be handled with impunity. When molested they discharge a violet fluid from the edge of the internal surface of the mantle, which does not injure the skin, has but a faint smell, and changes to wine-red.

"Wonderful tales used to be told of the more than poisonous qualities of the Aplysia. Pliny, Ælian, and especially Aldrovandi, collected all these absurd notions. One was that if the animal were touched, even with a walking-stick, the danger would be not less than from the look of a basilisk; another was that it caused baldness; and a third that pregnant women miscarried at the sight of this horrid creature. Cuvier has satisfactorily shown that Aplysia is quite harmless, and that it did not deserve the bad character given to it by the ancients; he says truly that fishermen have always had a fancy to attribute mischievous properties to those marine animals which are of no use as the food of man. I would remark, however, by way of parenthesis, that the Aplysia is not quite inoffensive, as any one may be convinced by handling it; the smell is insufferably nauseous. This and its slabby appearance are certainly enough to take away the appetite of any civilized being. But Mr. Lesson states that one kind is eaten raw and esteemed a delicacy by the natives of the Society or Friendly Isles. The Aplysiæ secrete occasionally a whitish slime. Spawn-case gelatinous, of a pinkish hue, thread-like, and irregularly convoluted; ova white and very numerous, lying in the middle. The embryonic shell is globular; it becomes the apex in after-growth, being persistent, as in Teredo."—JEFFREYS, *Brit. Conch.*

PHYLLAPLYSIA, Fischer.

Distr.—3 sp. Europe. *P. ornata*, Desh. (lxxxix, 69).

Body flat, neck short, foot broad, natatory lobes small. Shell absent or horny (?). Teeth of radula tricuspid, blunt. Copulation reciprocal, as in Helix, not in multiple chains, as in true Aplysia.

APLYSIELLA, Fischer.

Distr.—2 sp. Europe. *A. petallifera*, Rang (lxxxix, 72).

Aplysia, with the natatory lobes rudimentary as in Dolabella, the shell very thin.

DOLABRIFERA, Grube.

Distr.—4 sp. Indian Ocean, West America. *D. Cuvieri*, Ads. (lxxxix, 73).

Shell trapezoidal; side-lobes not used for swimming.

DOLABELLA, Lamarck.

Etym.—*Dolabella*, a small hatchet.

Distr.—12 sp. Mediterranean, Mauritius, Ceylon, Society Islands, Sandwich Islands. *D. Teremidi* (lxxxix, 74, 75).

Shell hard, calcareous, trigonal, with a curved and callous apex.

Animal like Aplysia, with gill near posterior extremity of the body and lateral crests closely appressed, leaving only a narrow opening; ornamented with branching filaments.

SIPHONOPYGE, Brown.

Distr.—6 sp. West America, Chinese Sea. *S. lurida*, d'Orb. (lxxxix, 76, 77).

Shell truncated in front; foot-lobes spread out for swimming; posterior part extended beyond the siphon.

NOTARCHUS, Cuvier.

Etym.—*Notos*, the back, *archos*, vent.

Syn.—Busiris (*griseus*), Risso.

Distr.—7 sp. Mediterranean, Red Sea, living in floating masses of sea-weed. *N. ocellatus*, Rang (lxxxix, 78).

Animal ornamented with filaments, sometimes dendritic, foot narrow, lateral crests united, leaving only a narrow branchial slit; gills not covered by an opercular mantle-lobe.

Notarchus was long supposed to be without a shell; it is present, however, paucispiral, only a millimetre in diameter, and concealed under the mantle at the posterior part of the visceral mass.

ACLESIA, Rang.

Distr.—Several sp. East Indies. *A. rufa*, Quoy (lxxxix, 79).

Animal elongated, with a pointed posterior termination covered with filiform appendages; four long tentacles; gills in a branchial cavity. No shell.

BURSATELLA, Blainville.

Distr.—*B. Leachii*, (lxxxix, 80).

Subglobular, the natatory appendages united together on the back, leaving a dorsal cavity containing the anus and a large free gill; four ramified tentacles, and two buccal appendages. No shell. Is possibly identical with Aclesia, the globular shape being due, perhaps, to immersion in alcohol.

STYLOCHEILUS, Gould, 1841.

Distr.—3 sp. New Guinea, on Fuci. *S. longicauda*, Quoy (lxxxix, 81).

Animal limaciform; cirrigerous, dilated at the sides, attenuated behind; neck distinct; tentacles four, long, linear, papillose, far apart; lips dilated laterally into tentacular processes.

FAMILY PLEUROBRANCHIDÆ.

Shell limpet-like or concealed, rarely wanting; mantle or shell covering the back of the animal; gill lateral, between the mantle-margin and foot; food vegetable, stomach extremely complicated.

The animals of this family have no upper jaw, the lingual membrane is armed with numerous short teeth, arranged in a quincunx; there are four stomachs, the second of which is fleshy, and sometimes furnished with bony pieces, and the third is provided internally with prominent longitudinal lamellæ; the intestinal canal is short. The species are tolerably numerous, occasionally of large size and adorned with varied colors; they are mostly inhabitants of the high seas.

PLEUROBRANCHUS, Cuvier.

Etym.—*Pleura*, side, *branchia*, gill.

Syn.—Berthella, Bl. Oscanius, Gray. Haliotinella, Souverb.

Distr.—22 sp. South America, Norway, Britain, Mediterranean, Red Sea, Ceylon. *P. citrinus*, Rüppell (lxxxix, 82, 83).

Shell internal, large, oblong, flexible, slightly convex, lamellar, with a posterior, subspiral nucleus.

Animal oblong, convex; mantle covering the back and sides, papillated, containing spicula; foot large, separated from the mantle by a groove; gill single, free at the end, placed on the right side between the mantle and foot; orifices near the base of the gill; head with two grooved tentacles, eyes at their outer bases; mouth armed with horny jaws and covered by a broad veil with tentacular lobes.

PLEUROBRANCHÆA, Meckel. (Pleurobranchidium, Blainv.) Mantle-margin very narrow, not concealing the gill; dorsal tentacles ear-like, oral veil tentaculiform. *P. Meckelii*, Blainv. (lxxxix, 90).

KOONSIA, Verrill, 1882. (Dedicated to B. F. Koons, U. S. Fish Commission.) Allied to Pleurobranchæa, with which it agrees in the character of the head, tentacles, proboscis and gill. It differs in having the back swollen and overhanging both on the sides and posteriorly, and a distinct mantle-edge all around, with a wide groove between it and the foot posteriorly, as well as laterally; the foot is narrower and prolonged posteriorly, with a specialized glandular area, near the end, beneath, and a conical papilla above near the tip. The external reproductive organs appear less complicated than in Pleurobranchæa. The verge is armed with small hooks, but the spicule, present in the latter genus, is not protruded, if present, in the specimens of Koonsia; urinal opening at the anterior root of the gill; between this and the verge, some specimens show a small opening and a low papilla, but none show the large opening and long flat papilla

of Pleurobranchæa; anal opening behind the base of the gill; gill large, bipinnate, fully exposed on the right side, between the mantle and the foot. *Distr.*—*K. obesa*, Verrill. Atlantic Coast, United States.

POSTEROBRANCHÆA, d'Orbigny.

Distr.—*P. maculata*, d'Orbigny (lxxxix, 91). Coast of Chili.

Animal shell-less; oval, depressed, covered by a mantle broader than the foot; foot oblong, bilobed behind; branchial plume on the left side, projecting posteriorly; reproductive orifice in front of gill, excretory behind; proboscis covered by a broad bilobed veil; no dorsal tentacles.

RUNCINA (Forbes), Hancock.

Syn.—? Pelta, Quartr. (not Beck).

Distr.—On Confervæ near high-water mark, Torbay; feeds apparently on Diatomaceæ. *R. Hancocki*, Forbes (lxxxix, 84; xci, 44).

Animal minute, slug-like, with a distinct mantle; eyes sessile on the front part of the mantle; no tentacles; gills three, slightly plumose, placed with the vent on the right side, at the hinder part of the back, beneath the mantle; gizzard armed; reproductive organs on the right side. Dentition (xiii, 70).

NEDA, H. and A. Adams.

Distr.—*N. luniceps*, Cuv. (lxxxix, 85). South Europe.

Animal shell-less; mouth terminating a proboscis, which is long and thin; oral veil half-moon shaped, with two lateral recurved tentacles.

SUSANIA, Gray.

Distr.—*S. testudinaria*, Phil. (lxxxix, 86).

Mantle very large, broadly margining the foot, vesicular, deeply notched in front; frontal veil between the base of the tentacles and mouth large and oblong; foot oblong, rather narrow. Shell very small.

FAMILY UMBRELLIDÆ.

Shell depressed patelliform, thin, calcareous.

Tentacles dorsal, ear-like, with plicate cavities at their bases; mouth proboscidiform, retractile, covered by a small oral veil with moderate labial appendages, and concealed in the notch at the fore-part of the foot. Foot large and thick, deeply fissured in front, the sides tubercular.

UMBRELLA, Lam.

Chinese umbrella-shell.

Syn.—Operculatum, Linn. (part). Acardo, Lam. Gastroplax, Bl.

Distr.—6 sp. Canaries, Mediterranean, India, China, Sandwich Islands. Fossil, 4 sp. Jurassic—; United States, Sicily, Asia. *U. Mediterranea*, Lam. (lxxxix, 87). *U. Indica*, Lam. (lxxxix, 88).

Shell limpet-like, orbicular, depressed, marked by concentric lines of growth; apex subcentral, oblique, scarcely raised; margins acute; inner surface with a central colored and striated disk, surrounded by a continuous irregular muscular impression. It has a minute sinistral nucleus.

TYLODINA, Rafinesque.

Distr.—3 sp. Mediterranean, Norway. Fossil, 1 sp. Tertiary. *T. punctulata*, Raf. (lxxxix, 89).

Shell limpet-like, depressed, apex subcentral, with a minute spiral nucleus.

Animal oblong, foot truncated in front, rather pointed behind; dorsal tentacles ear-like, with eyes sessile at their inner bases; oral tentacles broad; branchial plume projecting posteriorly on the right side.

ORDER NUDIBRANCHIATA.

Animal destitute of a shell except in the embryo state; branchiæ always external, on the back or sides of the body. Sexes united.

The Nudibranchiate sea-slugs are found on all coasts where the bottom is firm or rocky, from between tide-marks to a depth of fifty fathoms; a few species are pelagic, crawling on the stems and fronds of floating sea-weed. They have been found in the Icy Sea, at Sitka, and in the sea of Ochotsk; in the tropical and southern seas they are abundant. They require to be watched and drawn whilst living and active, since after immersion in spirits they lose both their form and color. In some the back is covered with a mantle (viii, 39), which contains calcareous spicula of various forms, sometimes so abundant as to form a hard shield-like crust. The dorsal tentacles and gills pass through holes in the mantle somewhat like the "key-hole" in Fissurella. In others there is no trace of a mantle whatever. The eyes appear as minute black dots, immersed in the skin, behind the tentacles; they are well organized and conspicuous in the young, but often invisible in the adult. The dorsal tentacles are laminated, like the antennæ of many insects; they are never used as organs of touch, and are supplied with nerves from the olfactory ganglia. The Dorididæ are distinguished by having a short and wide lingual membrane with numerous similar teeth; the Æolids have a narrow ribbon with a single series of larger teeth. In Dendronotus a large central tooth is flanked by a few small denticulated teeth.

The only Nudibranch with a solid upper jaw, is *Ægirus punctilucens.* In other instances the two halves are articulated and act as lateral jaws. In Ægirus the mouth is also furnished with membranous fringes. *Ancula cristata* has a formidable spinous collar. The skin acts as an accessory breathing-organ; it performs the function entirely in the Elysiadæ, and in the other families, when by accident the branchiæ are destroyed. The water on the gills is renewed by ciliary action. The fry is provided with a transparent, nautiloid shell, closed by an operculum, and swims with a lobed head-veil fringed with cilia, like the young of most other gastropods.

"While the numerous tribes of Mollusks furnished with testaceous coverings offer us objects of contemplation remarkable alike for their extreme beauty and the durability of their calcareous envelopes, the scarcely less extensive and certainly far less known families of naked-gilled gastropods exhibit an astonishing variety of form, extreme delicacy of organization, and great diversity of color to captivate the eye and occupy the attention of those who wander by the shore or explore the depths of the ocean. Clinging to the stems of floating seaweeds, many, like the Anthobranchs, will be seen extruding their flower-like gills of surpassing elegance, exploring with their foliated tentacles or complex mantle-filaments the plants around them, the brilliant hues of their striped or spotted bodies glancing through the water; some will be observed with bodies so fragile and pellucid that you may see the color of their blood and count the pulsations of their hearts; some will be seen to have their gills disposed in rows of papillary tubercles on the sides of their bodies, like the Æolids, or tree-like and branching, like the Tritonias; the foreheads of some will be smooth and simple, while those of others will be found adorned with various singular appendages; in others, again, all processes will disappear, all branchial arrangements vanish, and we shall meet with forms almost as simple in their appearance as the Nemertoid types among the Annelids."—H. and A. Adams.

Suborder *ANTHOBRANCHIATA.*

The branchiæ more or less surrounding the anus upon the medio-dorsal line.

Family DORIDIDÆ.

Mantle (nothæum) large, without marginal appendages; skin generally very spiculose; dorsal tentacles (rhinophora) laminate and retractile within cavities. Dentition (xiii, 69).

Doris, Linn.

Syn.—Argus, Bohadsch. Archidoris, Bergh.

Distr.—157 sp. Universal. *D. Johnstoni*, Alder and Hancock (xc, 92).

Body depressed, or subconvex; integument spiculose; mantle often tuberculate, covering the head and the foot; branchiæ plumose or ramose, united at the base, and retractile with the anus into a common pallial cavity; mouth inferior, with two distinct oral tentacles (rarely absent); odontophore broad, with numerous spines in each transverse row. Bergh has proposed the name ARCHIDORIS for the thus restricted typical group.

ANGASIELLA, Crosse, 1864.

Distr.—*A. Edwardsi*, Angas. Australia.

Body elongate, rounded in front, attenuated and produced into a point behind; mantle everywhere covering the head and foot; dorsal tentacles 2; subclavate; branchiæ plumose, few, and placed before the anus, a little behind the middle of the back.

As M. Crosse has told us nothing about the retractility of the branchiæ or the condition of the oral tentacles, odontophore, etc., we cannot be certain of the position of this group.

KENTRODORIS, Bergh, 1876.

Distr.—3 sp. Australasia. *K. rubescens*, Bergh.

Mantle broad, soft, with the upper side everywhere minutely granular; rhinophores retractile; tentacles conical; branchiæ retractile, the plumes tripinnate, podarium broad, the margin in front deeply grooved, with the upper lip veliform and deeply emarginated; rounded behind; no buccal armature; no median tooth, the lateral ones uncinate. Penis armed with a spine.—BERGH.

CHROMODORIS, Ald. and Hanc., 1855.

Syn.—Doriprismatica, d'Orb, 1837 (part). Goniodoris, Gray, 1850 (part). Goniobranchus, Pease, 1866. Hemidoris, Stimpson, 1855.

Distr.—97 sp. Medit., Red Sea, Indian Ocean and Australasia. *C. magnifica*, Quoy (xc. 93).

Body elongate, subquadrate; mantle narrow, covering the head but not the extremities of the foot; generally smooth and marked with bright colors in stripes or spots; oral tentacles conical or tubercular. Branchiæ linear, usually pinnate, retractile in a common cavity. Odontophore broad, with numerous transverse rows of many close-set plates, each bearing two large spines, one in front of the other, the posterior one bearing denticulations, no central plate; a buccal collar, formed of two broad plates, bearing close minute bifid spines.

APHELODORIS, Bergh. Somewhat like Chromodoris, but mantle and foot narrow; tentacles truncate, canaliculate; gills retractile, consisting of five tripinnate leaves; labial disk unarmed. Radula without median plate, lateral plates with many hooked teeth. *A. Antillensis*, Bergh. St. Thomas, W. I.

HOMOIODORIS, Bergh, 1881.

Distr.—*H. Japonica*, Bergh. Japan.

Form of the body as well as the rhinophores, tentacles and branchia as in Archidoris; prostate large; vagina armed.

PETELODORIS, Bergh, 1881.

Distr.—*P. triphylla*, Bergh. Japan.

Body subdepressed, the back minutely hirsutely tuberculated; branchial aperture valved; branchial leaves tripinnate; tentacles short, triangular; penis unarmed.

ORODORIS, Bergh, 1875.

Distr.—*O. miamirana*, Bergh. Tahiti.

Mantle (nothæum) somewhat as in Miamira. Keeled above with transverse ribs; no frontal or caudal veils, or lateral lobes lamellate beneath. Foot rather narrow. Integument without spicules. Armature of the oral aperture as in Miamira—a spinous buccal collar. Odontophore as in Miamira; but the rachis is hardened.—BERGH.

CERATODORIS, Gray.

Syn.—Echinodoris, Bergh, 1874.

Distr.—*C. solida*, Quoy (xc, 1). Waigiou.

Form rather depressed; back everywhere covered with elongated papillæ; back and papillæ spiculose. Rhinophores and branchiæ retractile. Odontophore with the pleuræ multidentate. Penis armed at the apex with a series of minute uncini.—BERGH.

HEXABRANCHUS, Ehr., 1831.

Syn.—Heptabranchus, Adams. Rhacodoris, Mörch (part).

Distr.—18 sp. Red Sea, Indian O., and Australasia. *H. sanguineus*, Rüppell (xc, 94).

Body soft; integument non-spiculose (?); rhinophores sharply bent, and with an anterior knee, retractile within marginated cavities; branchiæ generally small, numerous, ramose, non-retractile, arranged in six or eight tufts, which are set in an open circle at some distance around the anal opening; oral tentacles large, fleshy, flat, ovoid or leaf-shaped, with crenulated edge. Odontophore broad, with numerous lateral simple spines in each transverse row; none median in position.

CALYCIDORIS, Abraham, 1876.

Distr.—*C. Güntheri*, Abr. Hab—.

Body depressed: mantle ample, covered with soft papillæ; branchiæ simply laminate, arranged like a cup around the anus, subretractile in a common cavity. Oral tentacles represented by a fleshy, laterally extended veil. Odontophore narrow, bearing

two bicuspid spines, one each side, in each transverse row; no central spine, spinous collar, or under jaw.

LAMELLIDORIS, Ald. and Hanc., 1855.

Syn.—Onchidoris, De Blainv., 1816. Onchidorus, Ferussac, 1821. Onchidora, Cuv., 1830. Villiersia, d'Orb., 1837. Oncidiodoris, Agassiz, 1847. Oncodoris, Agassiz, 1847.

Distr.—23 sp. E. Coast of N. Am., W. Coast of Europe, and New Zealand. *L. Leachii*, Blainv. (xc, 95). *L. scutigera*, d'Orb. (xc, 96).

Body depressed; mantle large; head with a veil in place of oral tentacles; branchiæ simply pinnate, set in an open circle or ellipse, non-retractile. Odontophore narrow, with a few spines in each transverse row.

ACIODORIS, Bergh, 1879. General form like Lamellidoris, but suctorial proventricle simple, and 12–13 lateral teeth on the radula; male organ armed with simple or forked hooks. *L. lutescens*, Bergh. N. Pacific.

ADALARIA, Bergh, 1879. Like Lamellidoris, but radula with small flat (spurious) median plates and a large hook-shaped lateral tooth. *A. Pacifica*, Bergh.

ACANTHODORIS, Gray, 1850.

Distr.—4 sp. Universal. *A. pilosa*, Müll. (xc, 97).

Body convex; mantle moderate in size, covered with soft papillæ; oral tentacles united in a veil, with free flattened lateral ends; branchiæ united at the base, non-retractile. Odontophore narrow, with two large spines and several rudimentary ones in each transverse row; none central, usually a spinous buccal collar and rudimentary under jaw.

DICTYODORIS, Bergh, 1881.

Distr.—*D. tessellata*, Bergh. Pelew Islands.

Body depressed, coriaceous, smooth above; branchial aperture rounded, with few compound gill-leaves; tentacles finger-shaped; foot in front scarcely bilabiate. Radula without median plate, and with many-toothed pleuræ, the teeth hook-like, the external pectinate at the tip. No peculiar armature in the lips or penis.

DIAULULA, Bergh, 1879.

Distr.—*D. Sandiegensis*, Cooper.

Back minutely shaggy; tentacles finger-shaped; gill-leaves tripinnate; radula without median plates.

ARTACHÆA, Bergh, 1881.

Distr.—*A. rubida*, Bergh. Philippines.

Body depressed, verruculose above; tentacles finger-like; branchial leaves tripinnate; foot rounded in front; penis armed with hooks.

CADLINA, Bergh, 1879.

Distr.—3 sp. N. Atlantic, N. Pacific. *C. repanda*, Ald. and Hanc.

Back granulated, gill formed by a few tripinnate leaves; tentacles flattened, triangular; lips armed by minute hooklets; radula with a median-toothed plate, many-toothed lateral plates; male organ armed with hooklets.

JORUNNA, Bergh, 1879.

Distr.—N. Pacific Ocean. *J. Johnstoni*, Ald. and Hanc.

Back minutely granulated; gill-leaves tripinnate; tentacles finger-shaped; radula without median plate; lateral plates many-toothed; male organ armed with a sting.

ALDISA, Bergh.

Example.—*A. Zetlandica*, Ald. and Hanc.

Back almost shaggy, soft; gills composed of six tripinnate leaves; tentacles wart-shaped. Radula without median plate, lateral plates many-toothed, teeth erect, staff-like, denticulate externally.

ROSTANGA, Bergh.

Example.—*Doris coccinea*, Forbes.

Back minutely granulate, gills composed of sixteen bipinnate leaves; tentacles finger-shaped. Radula without median plate, lateral plates many-toothed, teeth bifid at the tips.

DISCODORIS, Bergh.

Distr.—*D. Boholensis*, Bergh. Philippines.

Body depressed, rounded or oval, granulate above; branchial aperture slightly crenulate or bilabiate; anterior margin of the foot bilabiate, the upper lip fissured; labial laminæ forming minute hooks.

HOPLODORIS, Bergh, 1881.

Distr.—*H. desmoparypha*, Bergh. Pelew Islands.

Armature of the lips consisting of very small rods; penis armed with several series of conical prominences; a horn-shaped dart and a dart-gland present; in other respects like Discodoris.

ASTERONOTUS, Ehrenberg.

Distr.—5 sp. *A. Hemprichii*, Ehrenb.

Body depressed, coriaceous; smooth above, frequently nodose, with a median carina; branchial aperture stellate; foot bilabiate in front, the upper lip profoundly fissured; labial armature none.

SPHÆRODORIS, Bergh.

Syn.—Actinocyclus, Ehrenb.

Distr.—2 sp. Philippines. *S. grandiflora*, Rapp (xc, 98).

Body ovate or rounded, cancellate above and set with tubercles: tentacles none; branchiæ simply lamellate; anal aperture nearly central; foot wide, anterior margin strongly emarginate; labial armature of small hooks.

DORIDUNCULUS, Sars.

Distr.—*D. echinulatus*, Sars. Norway, etc.

Mantle short, broad, with elongate spicula; two longitudinal ridges on its back; gills not retractile.

PLATYDORIS, Bergh.

Distr.—16 sp. West Indies, Philippines, Mediterranean. *P. argo*, Linn.

Body flattened, coriaceous, rigid, minutely granulated on the back; branchial opening stellate; anterior margin of foot bilabiate, superior lip profoundly cut; no labial armature. Dentition: no rachidian teeth, pleuræ multidentate, teeth hamate.

PELTODORIS, Bergh.

Distr.—*P. atromaculata*, Bergh. Naples.

Body subdepressed, oval, rather rigid, minutely granulate above; tentacles finger-like; branchial aperture rounded; branchiæ paucifoliate, tripinnated; labial armature none.

CREPIDODORIS, Pagenstecher.

Example.—*C. plumbea*, Pagenst.

Gills twenty-two, most of them arranged in the figure of a horseshoe, a few at the end placed more inwards.

THORDISA, Bergh.

Example.—*T. maculigera*, Bergh.

Form of body and radula nearly as in Discodoris; back almost villous; no labial armature.

TRIPPA, Bergh.

Example.—*T. ornata*, Bergh.

Form of the body depressed, smooth, tuberculate above and the tubercles villous; tentacles small; foot wide; no labial armature.

HALGERDA, Bergh.

Example.—*H. formosa*, Bergh.

Body subdepressed, subridged, smooth above; branchial aperture ovate; branchiæ sparsely tripinnate; tentacles none; foot narrow; no labial armature.

ATAGEMA, Grube.

Distr.—*A. carinata*, Quoy (xc, 99). New Zealand.

Mantle with longitudinal ridge on the back; tentacles clavate, retractile; gills very small.

FAMILY DORIDOPSIDÆ.

Doris-like Mollusca, without well-developed spicula in the integument, with mouth suctorial, opening on the front margin of the foot, with a retractile proboscis, but destitute of odontophore, jaws, or spinous collar.

The absence of an odontophore, so generally possessed by the cephalophorous Mollusca, justified Messrs. Alder and Hancock in raising this group to the rank of a family.

DORIDOPSIS, Ald. and Hanc., 1864.

Syn.—Doriopsis, Pease, 1860. Rhacodoris, Mörch, 1863 (part). Haustellodoris, Pease, 1871.

Distr.—72 sp. Universal. *D. viridis*, Pease (xc, 100).

Body more or less depressed, ovate or elliptical. Mantle ample, covering the head and foot, smooth or with soft tubercles and without marginal appendages. Rhinophores laminated and retractile within cavities. Head indistinct, generally with two small lateral lobes, but without proper oral tentacles. Branchiæ generally ramose, retractile with the anus into a common cavity.

DORIOPSELLA, Bergh. Distinct from Doridopsis by its somewhat rigid and granulated mantle. *D. areolata*, Bergh.

FAMILY POLYCERIDÆ.

Mantle small or obsolete, generally with marginal appendages, integument usually spiculose. Rhinophores various, often laminated. Messrs. Alder and Hancock divide the Polyceridæ into two sections, according as the rhinophores are retractile or non-retractile. This gives a convenient arrangement.

§ A. Rhinophores retractile within sheaths; the odontophore broad. (*Euryglossæ.*)

MIAMIRA, Bergh, 1874.

Distr.—*M. nobilis*, Bergh. Australasia.

Mantle (nothæum) anteriorly produced into a frontal veil, and furnished with lateral flattened lobes, lamellate below, behind continued into a caudal veil, above keeled and with transverse ribs. Oral aperture armed with a spinous buccal collar. Odontophore broad, with numerous series of teeth, many of them multidentate; the rachis armed.—BERGH.

CASELLA, H. and A. Ad.

Distr.—2 sp. Australasia. *C. Gouldii*, H. and A. Ad. (xc, 2).

Body compressed, elongated. Mantle-margin small, forming undulated lobate or erect crests along the sides of the back.

Rhinophores laminated, retractile. Foot narrow. Oral aperture armed. Odontophore with numerous minute spines, none median.

KALINGA, Ald. and Hanc., 1864. Body oval, subprismatic. Margin of mantle most developed in front, where there is a row of close-set papillated processes extending over the head; a few similar processes are upon the sides of the back. Rhinophores laminated. Oral tentacles flattened. Branchiæ non-retractile, placed separately in a circle at some distance around the anal opening. Odontophore broad, with numerous rather distant rows of tricuspid spines. No jaws or collar. *Distr.*—*C. ornata*, A. and H. Coromandel Coast.

TRIOPA, Johnston, 1838.

Syn.—Tritonia, Lam., 1801. Themisto, Oken (part), 1815. Euplocamus, Philippi, 1836 (part). Cadophora, Gray, 1840.

Distr.—9 sp. Universal. *T. claviger*, Müll. (xc, 3).

Body more or less depressed; mantle small, covering the head, the margin with linear subclavate or branched appendages; rhinophores laminated; oral tentacles cylindrical or ovoid; branchiæ few, non-retractile. Odontophore broad, with numerous plates, the two or three inner ones with large spines, none central.

Triopa was instituted by Johnston for the *Doris clavigera* of Müller. Messrs. Alder and Hancock proposed to retain as well the genus Euplocamus for *E. croceus*, Philippi. The differences between the two genera, however, appear to be more of degree than kind, and serve better for distinguishing sections of one genus; moreover the latter name is in general use for a genus of insects as well as for a genus of birds. Euplocamus originally took in the Idaliæ. Oken's Themisto included *Polycera quadrilineata* and *Triopa clavigera*.

LATERIBRANCHIÆA, Stearns. Animal like Triopa, with a single series of gills on each side, central or subcentral and opposite. *L. festiva*, Stearns. California.

TRIOPELLA, Sars.

Distr.—*T. incisa*, Sars. Norway.

Distinct from Triopa by the broad mantle, which is bilobed behind, and has two longitudinal ridges on the back; radula like that of Ægirus.

TRIOPHA, Bergh, 1880.

Distr.—*T. Carpenteri*, Stearns. W. Coast of America.

Distinguished from Triopa by nodose or shortly ramose dorsal appendages and ear-shaped lower tentacles; five tripinnate branchial plumes; mouth with two strong horny plates. Radula with 3–4 lateral and 10–11 external (uncinal) plates on each

ISSA, Bergh.

Syn.—Colga, Bergh.

Example.—*I. lacera*, Bergh.

Frontal and dorsal appendages less developed than in Triopa, mouth with triangular jaw. Lingual armature consisting of a median row of plates, two strong lateral and seven external plates.

HETERODORIS, Verrill and Emerton, 1882.

Distr.—*H. robusta*, V. and E. Martha's Vineyard, Mass.

Form and general appearance like Triopa and Triopella, but stouter and without any trace of gills; mantle forming an edge all around the back; surface of the back with scattered papillæ; a longitudinal crest between and behind the dorsal tentacles, which are lamellose and retractile, without sheaths, but with a prominent fold of the mantle-margin in front of them; head large, rounded, with a free, thin margin, which has a flat tentacular lobe on each side; foot broad, rounded in front; a large opening, apparently the anus, on the right side between the mantle and the foot, behind the middle; verge, as protruded, stout, cylindrical, swollen and rounded at the end, not armed; a short, stout, conical papilla just behind its base, and a lobe below it; farther back, nearer the anal (?) opening, there is a small, simple opening, probably urinal. Odontophore broad, with very numerous small, strongly hooked acute teeth in each row, all similar except a few near the centre, which are less curved and not so acute; no median tooth.

THECACERA, Flem., 1838.

Distr—3 sp. W. Coast of Eur. *T. pinnigera*, Mont. (xc, 4).

Body limaciform, smooth; mantle obsolete; supracapital veil indistinct; rhinophores laminated; no oral tentacles; branchiæ non-retractile, with linear or tubercular lateral appendages. Odontophore broad, with 12–14 plates; the two inner on each side bearing bicuspid spines; no central plate. Small lateral corneous jaws.

CRIMORA, Ald. and Hanc., 1862.

Distr.—*C. papillata*, A. and H. Guernsey.

Body limaciform. Mantle nearly obsolete, forming a supracapital veil with branched appendages, and a papillated ridge along each side of the back. Rhinophores laminated. Oral tentacles tubercular. Branchiæ non-retractile, placed about two-thirds down the centre of the back. Tail short, without a dorsal carina. Odontophore broad, bearing 26 or 27 spines on each side, of three kinds: the inner one is large, hooked, and bicuspid; the next 5 or 6 are short and obtuse, and supported on quadrilateral plates; the rest very long, slender, and minutely denticulated on the inner margin. No central spine.

PLOCAMOPHORUS, Rüppell and Leuckart, 1828.

Syn.—Plocamoceros, Cuv., 1830. Plocamophorus, Gray, 1842. Peplidia, Lowe, 1842. Histiophorus, Pease, 1860.

Distr.—10 sp. Red Sea, Australasia. *P. ocellatus* (xc, 5).

Body limaciform. Mantle represented by a supracapital veil bearing tuberculate or branched appendages on the margin, and by two or three tubercular processes upon each side of the back. Rhinophores laminate. Oral tentacles flat. Branchiæ few, non-retractile. Tail dorsally carinated. Odontophore with the spines near the middle bicuspid, none median in position. An incomplete buccal collar.

ÆGIRUS, Lovén, 1846.

Distr.—3 sp. European coasts. *Æ. punctilucens*, d'Orb. (xc, 6, 7).

Body convex, covered with large tubercles. Mantle indistinct, represented by a supracapital veil, and by a tubercular ridge along each side. Rhinophores linear, smooth or hispid. Branchiæ non-retractile. Odontophore with simple, curved, lateral spines; no central spine. An upper corneous jaw.

NOTODORIS, Bergh, 1875.

Distr.—*N. citrina*, Bergh. Rarotonga.

Body limaciform (the back not distinct from the sides). Rhinophores smooth, retractile in cavities protected by valves. No buccal armature. Lingual teeth, none median, the lateral ones erect and hook-shaped.—BERGH.

CERATOSOMA, Ad. and Reeve, 1848.

Distr.—8 sp. Australasia and Canary Isles. *C. cornigerum*, Ads. and Reeve (xc, 8).

Body elongate, prismatic, smooth, ending in a bluntly pointed tail; the dorsal surface passes into a post-branchial flesh protuberance. Mantle obsolete. Rhinophores laminated. Branchiæ with the roots more or less coherent, placed in front of and partially around the tubular anus, with which they are retractile into a common, smoothly margined cavity. Odontophore with numerous rows of simple spines, none of which are central. A spinous buccal collar.

TREVELYANA, Kelaart, 1858.

Syn.—Gymnodoris, Stimpson, 1855. Stenodoris, Pease, 1866.

Distr.—11 sp. Red Sea, Indian Ocean and Australasia. *T. Ceylonica*, Kelaart (xc, 9).

Body limaciform, rather swollen or raised on the central region. Mantle obsolete; no appendages; rhinophores laminated and

retractile; branchiæ pinnate and non-retractile, placed roun the anus almost on the centre of the back. Mouth without ora tentacles or veil, and without collar or jaws; odontophore broad bearing simple spines.

NEMBROTHA, Bergh.

Distr.—6 sp. Pacific. *N. nigerrima*, Bergh.

Body limaciform, back and sides not separated; tentacle short, lobiform; branchiæ not retractile, sparsely foliate, almos in the middle of the back; foot narrow; labial armature smal or none (?).

§ B. Rhinophores non-retractile; odontophore narrow. (*Ster oglossæ.*)

GONIODORIS, Forbes, 1840.

Syn.—Doriprismatica, d'Orb., 1837 (part). Pelagella, Gray 1850.

Distr.—9 sp. Universal. *G. nodosa*, Mont. (xc, 10).

Body rather depressed; mantle distinct with waved or sca loped margin. Rhinophores laminated; oral tentacles flattened branchiæ non-retractile; odontophore with four plates in eac transverse row; the two next the median line bearing each large spine; no central plate. A spinous buccal collar.

AETHEDORIS, Abraham, 1876.

Distr.—*A. Indica*, Ald. and Hanc. Madras Coast.

Alder and Hancock figure in vol. 5 of the Zoological Society Transactions, a form belonging to a new genus "apparentl related to Goniodoris." As no specimen came into their hand they could give no description. The most striking characte istic seen in the drawing is the expansion of the bilobed head each lobe being semicrescentic, with the apex curved backward and the margin bearing twelve to fourteen conical dentations.

IDALIA, Leuckart, 1828.

Syn.—Euplocamus, Philippi, 1836 (part).

Distr.—8 sp. Europe and China. *I. aspersa*, Ald. and Han (xc, 11).

Body convex, smooth. Mantle indistinct, the margins bearin filaments, generally longest in front. The head is produce anteriorly. Rhinophores linear, laminated. Branchiæ simpl pinnate, non-retractile. Odontophore with four spines in eac transverse row, the two middle ones large, no central spines. A spinous buccal collar.

IDALIELLA, Bergh, 1881. Differs in the absence of cirri i the middle of the back, and in the lateral lamellæ of the hooklet on the lips. *I. inæqualis*, Forbes and Hanley.

ANCULA, Lovén, 1846.

Syn.—Miranda, Ald. and Hanc., 1847. Drepania, Lafont, 1874.

Distr.—3 sp. N. Atlantic O. *A. cristata*, Ald. and Hanc. (xc, 12).

Body limaciform, smooth. Mantle obsolete, forming an indistinct ridge near the branchiæ, bearing one or more appendages. Rhinophores laminate, bearing styliform basal appendages. Head produced at the sides into tentacular processes. Odontophore with four spines in each transverse row, the two next the median line large and broad, with the inner margin denticulated; no central spine. A spinous buccal collar.

M. Lafont states his Drepania to differ from Ancula in the head bearing two elongated tentacles analogous to those of Eolis, in the branchiæ not being surrounded by linear appendages, and in the rhinophore carrying but one filament instead of two. Unless the lingual character proves to be importantly different from that of Ancula, it would seem advisable to unite Drepania with the latter genus.

POLYCERA, Cuv., 1817.

Syn.—Themisto, Oken, 1815 (part). Cufæa, Leach, 1820.

Distr.—11 sp. Europe, Cape of Good Hope, Australasia. *P. quadrilineata*, Müll. (xc, 13).

Body limaciform. Mantle indistinct, forming a supracapital veil, and a tuberculated ridge on the sides. Rhinophores laminated. Branchiæ non-retractile, with lateral appendages. Odontophore with twelve to sixteen plates in each transverse row, the two near the centre large and bicuspid; no central spine. Lateral corneous jaws.

PALIO, Gray. Frontal veil short, bilobed, tuberculated on the edge; gills branched, with more than one tubercular appendage on each side. *P. ocellata.*

POLYCERELLA, Verrill, 1880. Body elongated-ovate, having the the same form as Polycera. Mantle little developed. Dorsal tentacles (rhinophores) not laminated and not retractile, without sheaths. A row of papillæ along each side of the back, extending beyond the gills. Gills three, pinnate, situated in the middle of the back, nearly as in Polycera. Foot auricled. Odontophore with six rows of teeth; median row absent; inner laterals large, curved, with three denticles, two outer rows much smaller, simple, hook-shaped. *P. Emertoni*, Verrill. New England.

BRACHYCHLANIS, Ehrenb., 1831.

Distr.—*B. pantherina*, Ehrenb. Red Sea.

Mantle very small, forming a dorsal area, with narrow, upturned border. Rhinophores laminated, arising in front of the mantle-margin. Branchiæ retractile. Mouth terminal.

SUBORDER *AIOLOBRANCHIATA.*

Branchiæ variable, generally upon the sides of the back; not as in the last family, in a circle surrounding the anal orifice.

FAMILY TRITONIADÆ.

Animal with laminated, plumose, or papillose gills, arranged along the sides of the back; tentacles retractile into sheaths; lingual membrane with one central and numerous lateral teeth; orifices on the right side.

TRITONIA, Cuvier.

Syn.—Candiella, Gray.

Distr.—20 sp. Northern seas, Polynesia, Red Sea. Under stones at low-water to 25 fathoms. *T. Hombergii*, Cuvier, found on the English scallop-banks, attains a length exceeding 6 inches. *T. plebeia*, Johnst. (xc, 14).

Animal elongated; tentacles with branched filaments; veil fimbriately digitated; gills in single series on a ridge down each side of the back; mouth armed with horny jaws; stomach simple, liver compact.

MARIONIA, Vayssiere, 1879. Body elongate, sides compressed, mantle none; velum small, ramose, in a dorsal line; maxillæ corneous; stomach armed with cultriform teeth. *T. Berghi*, Vayss. Gulf of Marseilles.

CALIPHYLLA, Costa. Body long, narrow; tentacles two, foliaceous, longitudinally convolute; labial border bilobed; branchiæ foliaceous, vascular, numerous, in irregular, longitudinal series; anus on the right side behind the genital orifice. *Distr.*—*C. Mediterranea*, Costa. Mediterranean.

NEMOCEPHALA, Costa. Body Tritoniiform; anterior margin of the head semicircular, six-digitate, or divided into six simple, cylindrical tentaculiform processes; tentacles ramose, retractile into sheaths; branchiæ arborescent, on both sides of the back in single longitudinal series. Differs from Dendronotus in the six filaments being simple, not branched. *Distr.*—*T. marmorata*, Costa. Mediterranean.

HANCOCKIA, Gosse. Body linear, scarcely palliate, head produced on each side into a broad, flat, many-fingered veil; dorsal tentacles with laminated bulbs, retractile within sheaths; branchiæ three pairs, foliate, pinnatifid, infolding, remotely situated on the subpalliate margin of the back; foot linear, grasping. *Distr.*—*T. eudactylota*, Gosse.

TETHYS, Linn.

Etym.—*Tethys*, the sea (personified).

Syn.—Fimbria, Bohadsch.

Distr.—*T. fimbriata*, L. (xc, 15). Mediterranean. Attains a

foot in length, and feeds on other mollusks and crustaceans.—CUVIER.

Animal elliptical, depressed; head covered by a broadly expanded, fringed disk, with two conical tentacles, retractile into foliaceous sheaths; gills slightly branched, a single row down each side of the back; reproductive orifices behind first gills, vent on right side, behind second gill; stomach simple.

SCYLLÆA, Linn.

Etym.—*Scyllæa*, a sea-nymph.

Distr.—7 sp. Atlantic, South Britain, Mediterranean, Philippines, on floating sea-weed. *S. pelagica* (xc, 16). *S. Grayi*, Ads. (xc, 17).

Animal elongated, compressed; foot long, narrow, and channeled, adapted for clasping sea-weed; back with two pairs of wing-like lateral lobes, bearing small tufted branchiæ on their inner surfaces; tentacles dorsal, slender, with lamellated tips, retractile into long sheaths; lingual teeth 24·1·24, denticulated; gizzard armed with horny knife-plates; orifices on the right side.

NEREA, Lesson. 10 lines long, with ear-shaped tentacles, and 3 pairs of dorsal lobes. *N. punctata*, Lesson.

MELIBE, Rang.

Syn.—Chiorhæa, Gould.

Distr.—*M. rosea*, Rang (xc, 18). *M.* (*Chiorhæa*) *leonina*, Gld. (xci, 19).

Head unusually large, upper tentacula or rhinophoria retractile, perfoliate; pharynx with a strongly toothed jaw, but without radula; back with unequal leaf-, tree- and club-shaped papillæ; no distinct gills.

DENDRONOTUS, Alder and Hancock.

Etym.—*Dendron*, a tree, *notos*, the back.

Distr.—Northern; on sea-weed and corallines; low-water to corralline zone. *D. arborescens* (xci, 20).

Animal elongated; tentacles laminated; front of the head with branched appendages; gills arborescent, in single series down each side of the back; foot narrow; lingual teeth 10·1·10; stomach and liver ramified.

LOMANOTUS, Verany.

Syn.—Eumenis, A. and H.

Distr.—3 sp. Britain and Mediterranean, on corallines. *L. Genei*, Verany (xci, 21).

Animal elongated, smooth; head covered with a veil; tentacles clavate, laminated, retractile into sheaths; gills filamentose, arranged along the sides of the back, on the wavy margins of the mantle; foot narrow, with tentacular processes in front; stomach ramified.

BORNELLA (Gray), A. Adams.

Distr.—3 sp. Straits of Sunda, on floating weed; Borne
A. digitata, Ads. (xci, 22).

Animal elongated; dorsal tentacles retractile into branche sheaths; head with stellate processes; back with two rows cylindrical, branched, gastric processes, to which small dendrit gills are attached; foot very narrow.

SUBFAMILY *PROCTONOTINÆ.*

Branchiæ superficial, fusiform, on the sides of the back; te tacles simple, without sheaths; tongue broad, teeth many; jav horny, strong.

PROCTONOTUS, Alder and Hancock.

Syn.—Venilia, A. and H. Zephyrina, Quatref.

Distr.—3 sp. North Atlantic. *P. mucroniferus* (xci, 23).

Animal oblong, depressed, pointed behind; dorsal tentacl 2, linear, simple, with eyes at their base, behind; oral tentacl short; head covered by a small semilunar veil; mouth wi horny jaws; papillæ on ridges down the sides of the back ar round the head in front; vent dorsal.

ANTIOPA, Alder and Hancock.

Syn.—Janus, Verany.

Distr.—3 sp. Britain, Mediterranean. *A. spinolæ*, Vera (xci, 24).

Animal ovate-oblong, pointed behind; dorsal tentacles lam lated, united at the base by an arched crest; head with a sm veil and two labial tentacles; papillæ ovate, placed along t lateral ridges of the back and continuous above the head; ve central, posterior, sexual orifice at the right side; lingual tee numerous (?).

MADRELLA, Alder and Hancock, 1864.

Example.—*M. ferruginosa*, A. and H.

Differs from the other members of the family in the late position of the anus, and the absence of oral tentacles, unless t oral veil be considered such.

SUBFAMILY *DOTONINÆ.*

Tentacles retractile into sheaths; branchiæ superficial, fu form, on the sides of the back; tongue narrow, teeth in a sing central series.

? DOTO, Oken.

Etym.—*Doto*, a sea-nymph.

Distr.—4 sp. Norway and Britain, on corallines in de water to 50 fathoms. *D. coronata*, Gmel. (xci, 25, 26).

Animal slender, elongated; tentacles linear, retractile in

trumpet-shaped sheaths; veil small, simple; gills ovate, muricated, in single series down on each side of the back; lingual membrane slender, with above 100 recurved, denticulated teeth, in single series; foot very narrow.

The stomach is ramified, and the liver is entirely contained in the dorsal processes, which fall off readily when the animal is handled, and are soon renewed.

GELLINA, Gray. Head simple; papillæ or gills smooth. *D. affinis*, d'Orb. (xci, 27). North Sea.

DOTILLA, Bergh. Distinct from Doto by three rows of plates in the radula.

HERO, Lovén.

Syn.—Clœlia, Lovén. *Distr.*—*H. formosa*, Lov.

Animal with no mantle; tentacles two, linear, simple, non-retractile; veil plain, produced at the sides, gills branched or umbellated. Tongue with a large central denticulated spine, and two simple lateral spines. Jaws corneous.

HEROMORPHA, Bergh.

Distr.—*H. Antillensis*, Bergh. West Indies.

Agreeing with Hero in the general structure of the head and especially of the tentacles, but with cup-shaped rhinophores, of which the club is simple; also closely allied to Doto, but with simple papillæ.

FAMILY ÆOLIDÆ.

Animal with papillose gills, arranged along the sides of the back; tentacles subulate, sheathless, non-retractile; lingual teeth 0·1·0; jaws horny; ramifications of the stomach and liver extending into the dorsal papillæ; excretory orifices on the right side; skin smooth, without spicula; no distinct mantle.

SUBFAMILY *GLAUCINÆ*.

Branchiæ papillose, in groups; foot rudimentary.

GLAUCUS, Forster.

Etym.—*Glaucus*, a sea-deity.

Syn.—Pleuropus, Raf. Eucharis, Peron.

Distr.—7 sp. Atlantic, Pacific. Found on floating sea-weed; devours small sea-jellies, Porpitæ and Velellæ.—BENNET. *G. radiatus*, d'Orb. (xci, 28).

Animal elongated, slender; foot linear, channeled; tentacles four, conical; jaws horny; teeth in single series, arched and pectinated; gills slender, cylindrical, supported on three pairs of lateral lobes; stomach giving off large cœca to the tail and side-lobes; liver contained in the papillæ; sexual orifice beneath first dextral papilla, vent behind second papilla; spawn in a close spiral coil.

GLAUCUS (restricted). Includes the larger species; head small; body slender, with long tail; arms rather short, with the papillæ in one row; penis with a horny hook. 5 sp. Atlantic and Pacific Oceans.

GLAUCILLA, Bergh. Size smaller; head strong; body bulky, with short tail; arms more prominent, with the papillæ in several rows; penis without hook; no large urticating threads. 2 sp. Northern and Southern Pacific.

LANIOGERUS, Blainv. Elongated, subcylindrical; thick and wide anteriorly, narrower and thinner behind; having on each side a series of smooth, finely pectinated lamellæ, divided into two parts; four conical tentacles; generative and anal orifice upon the right side. *G. Elfortii*, Blainv. (xci, 29).

SUBFAMILY *ÆOLINÆ.*

Foot large; branchiæ in ranks on each side.

ÆOLIS, Cuvier.

Etym.—*Æolis*, daughter of Æolus.

Syn.—Psiloceros, Menke. Eubranchus, Forbes. Amphorina, Quatref.

Distr.—Norway, Britain (33 sp.), United States, Mediterranean, South Atlantic, Pacific. *Æ. papillosa*, L.

Animal ovate; dorsal tentacles smooth, oval, slender; papillæ simple, cylindrical, numerous, depressed, and imbricated; mouth with a horny upper jaw, consisting of two lateral plates, united above by a ligament; foot narrow; tongue with a single series of curved, pectinated teeth; spawn of numerous waved coils.

Found amongst rocks at low-water; they are active animals, moving their tentacles continually, and extending and contracting their papillæ; they swim readily at the surface, inverted. They feed chiefly on sertularian zoophytes, and if kept fasting will devour each other; when irritated they discharge a milky fluid from their papillæ, which are very liable to fall off.

FACELINA, Alder and Hancock. (Acanthopsole, Trinchese.) Body rather slender, rhinophores perfoliate; anterior angles of the narrow foot assuming the form of tentacles; middle part of the jaw strongly denticulated. (Nearly identical with Phidiana, Gray.) *F. coronata*, Forbes (xci, 30). 6 sp. Europe.

PHIDIANA, Gray. Labial tentacles subulate; branchiæ on both sides of the back, composed of cylindrical lobes, forming transverse rows for the whole length of the mantle; orifice tubercular, on the right side, below the first row of branchiæ; edge of jaw with a single row of denticles, and the radula has but few teeth, arranged in a single longitudinal row. Penis pointed. *P. Inca*, d'Orb. (xci, 32).

HERMISSENDA, Bergh, 1878. Near Phidiana, but anterior angles

of the foot tentaculiform; jaw with a single row of denticles. Radula consisting of one row of plates, their edge serrulate. Penis without hooks. *H. opalescens*, Cooper. California.

ÆOLIDIA, Cuvier.

Syn.—Æolidiana, Quatr. Cavolina, Brug., Orb. Montagua, Flem.

Distr.—4 sp. European seas. *Æ. annulata*, Quoy (xci, 31).

Rhinophores (upper tentacles) simple; the papillæ compressed, in transverse, rather distant rows; anterior angles of the foot almost rounded; middle projecting piece of the jaw not denticulated. Spawn of one or two coils.

ÆOLIDELLA, Bergh.

Distr.—4 sp. Europe.

Form of the body, tentacles and papillæ like those of Æolis; masticatory edge of the jaw minutely plaited; teeth of the radula in one row, comb-like, notched in the middle.

FLABELLINA, Cuvier.

Distr.—6 sp. Mediterranean, Phillipines. *F. coronata*, Forbes.

Body slender, rhinophores perfoliate; tentacles elongated; dorsal papillæ on compressed stalks; foot angularly produced in front; jaws minutely toothed-margined; radula uniserial. Spawn multispiral

PTERÆOLIDIA, Bergh.

Distr.—1 sp. *P. Semperi*, Bergh.

Rhinophores perfoliate; lower tentacles elongated; dorsal papillæ not caducous, on wing-like, compressed pediments; anterior margin of foot inflated, tentacularly produced at the sides; jaws toothed; radula uniseriate; penis unarmed.

CRATENA, Bergh.

Syn.—Cavolina, Brug., part. *Example.*—*C. hirsuta*, Bergh.

Rhinophores simple; anterior angles of the foot rounded; middle part of the jaw minutely denticulated. Spawn arranged in one or two coils.

GONIÆOLIS, Sars.

Distr.—1 sp. Norway.

Animal with a distinct mantle-border, which gives a square form to the body; tentacles not retractile, dorsal very large, labial placed at the sides of a large velum; dorsal papillæ simple, scattered on both sides of the back.

RIZZOLIA, Trinchese.

Example.—*R. peregrina*, Gmelin.

Near Cratena and Facelina by the dorsal appendages being

united on low pedicels, and by the simple, non-perfoliated upper tentacula. Armature of the mouth as in Facelina, radula uniserial, each plate crescent-shaped, with six to ten cuspids on either side; penis unarmed.

FAVORINUS, Gray.

Distr.—*F. albus*, Alder (xci, 33). North Sea.

Animal with slender cephalic tentacles knobbed at the extremity; oral tentacles two pairs; papillæ arranged in several oblique rows; jaws denticulated; dentition uniserial.

SPURILLA, Bergh.

Distr.—1 sp. Mediterranean.

Rhinophores perfoliate; anterior angles of the foot almost rounded; middle part of the jaw only, finely denticulated.

CORYPHELLA, Gray.

Distr.—18 sp. New England, Northern Europe. *C. Landsburgi*, Alder (xci, 34).

Rhinophores simple; angles of the foot produced; middle part of the jaw denticulated, lateral teeth of the radula minutely denticulated.

CALMA, Alder and Hancock.

Distr.—North Sea. *C. glaucoides*, A. and H.

Animal sharply angular in front; foot broad; papillæ simple and supported on cylindrical bases; tentacles small; jaws acutely toothed; radula triseriate.

GALVINA, Alder and Hancock.

Distr.—North Sea. *G. tricolor*, Forbes.

Rhinophores simple; papillæ swollen in distant transverse rows; anterior angles of the foot rounded; middle part of the jaw strongly denticulated; lateral teeth of the radula not denticulated.

TRINCHESIA, Ihering. Near Galvina, but only one plate in each transverse row of the radula. Several species at Naples.

CUTHONIA, Alder and Hancock.

Distr.—*C. nana*, A. and H. North Sea.

Animal with head naked and expanded; papillæ clavate and arranged in thick-set rows.

HERVIA, Bergh.

Distr.—1 sp. N. Europe.

Rhinophores simple; foot angularly produced in front; back papillary in oblique series; jaws with a single series of teeth; radula uniserial, sparsely dentate.

of the foot tentaculiform; jaw with a sin
Radula consisting of one row of plates, 1
Penis without hooks. *H. opalescens*, Coo

ÆOLIDIA, Cuvie

Syn.—Æolidiana, Quatr. Cavolin
Flem.

Distr.—4 sp. European seas.

Rhinophores (upper tentacles)
in transverse, rather distant r
almost rounded; middle pro
ticulated. Spawn of one or

Æoi

Distr.—4 sp. Europe

Form of the body, te
masticatory edge of
radula in one row, co

al ten
papillary

Distr.—6 sp.

Body slender
dorsal papillæ
in front; ja
Spawn mul

e sides of tl
g down its inner

BFAMILY *HERMÆIN*

lary; tentacles non-retrac
ous jaws.

Distr.
Rhin
papill
rior
jaw

ALDERIA, Allman.

Named after Joshua Alder, one
graph on the British Nudibranchia
—Styliger, Lovén.

tr.—4 sp. Norway, South Ireland, a
ta, Lovén (xci, 36).

nimal oblong, without tentacles; hea
pillæ arranged down the sides of the
sterior.

ERCOLANIA, Trinchese

Distr.—3 sp. Mediterranean.

Body subcylindrical; head small, withou
with rounded anterior angles; branchiæ
with whitish globules; rhinophores long,
canaliculate; anus in the middle of the
heart.

PHYLLOBRANCHUS, Alder and

Syn.—Lobifera and Polybranchia, Pease

Distr.—5 sp. Ceylon, Red Sea, Phil
Medit. *P. orientalis*, Kel.

branchiæ leaf-like, with distinct foot-stalks; ...ong, without sting.

...TILIGER, Ehrenb.

...urope, Massachusetts. *S. modestus*,

...f Galvina; rhinophores simple, ... papillæ club-shaped; foot ...h a sting.

...n.

H. dendritica, Alder

...ded longitudinally; papillæ ...sides of the back; sexual orifice ... dorsal, or sublateral, anterior.

CYERCE, Bergh.

... Pelew Islands. *C. elegans*, Semper.

...orsal; foot transversely bipartite; penis short, with sting.

EMBLETONIA, Alder and Hancock.

Etym.—Dedicated to Dr. Embleton, of Newcastle.

Syn.—Pterochilus, A. and H.

Distr.—4 sp. Scotland (2 sp.). In the littoral and laminarian zones. *E. pulchra*, A. and H. (xci, 38).

Animal slender; tentacles two, simple; head produced into a flat lobe on each side; papillæ simple, subcylindrical, in a single row down each side of the back.

TERGIPES, Cuvier.

Example.—*T. despectus*, Alder (xci, 39).

Tentacles subulate, smooth; branchiæ in a single row on each side, each with a sucker-like extremity; foot rudimentary. Spawn kidney-shaped.

FILURUS, DeKay.

Distr.—*F. dubius*, DeKay.

Foot stunted; body slender; tentacles two; mouth on a loose fringe of skin with two small oral feelers; papillæ in two long rows down the back.

FAMILY ELYSIIDÆ.

Animal shell-less, limaciform, with no distinct mantle or breathing-organ; respiration performed by the ciliated surface of the body; mouth armed with a single series of lingual teeth;

MATHARENA, Bergh.

Distr.—1 sp. N. Europe.

Papillæ in transverse and oblique series.

CÆCINELLA, Bergh.

Distr.—*C. luctuosa*, Bergh. Philippines.

Rhinophores sheathed; dorsal papillæ uniserial; with posterior claviform appendices; radula uniserial.

CERBERILLA, Bergh.

Distr.—1 sp. Samoa Islands.

Upper tentacles perfoliate, under tentacles elongate, dorsal papillæ situated on short pedicels; jaw smooth; teeth of the radula in a single row, irregularly denticulated.

FIONA, Alder and Hancock.

Syn.—Oithona, A. and H. (not Baird).

Distr.—4 sp. Falmouth. Under stones at low-water.—DR. COCKS. *F. nobilis*, A. and H. (xci, 35).

Animal elongated; oral and dorsal tentacles linear; mouth armed with horny jaws; gills (?) papillary, clothing irregularly a subpallial expansion on the sides of the back, each with a membranous fringe running down its inner side.

SUBFAMILY *HERMÆINÆ*.

Branchiæ papillary; tentacles non-retractile; mouth unarmed, or with corneous jaws.

ALDERIA, Allman.

Etym—Named after Joshua Alder, one of the authors of the "Monograph on the British Nudibranchiate Mollusca."

Syn.—Styliger, Lovén.

Distr.—4 sp. Norway, South Ireland, and South Wales. *A. modesta*, Lovén (xci, 36).

Animal oblong, without tentacles; head lobed at the sides; papillæ arranged down the sides of the back; vent dorsal, posterior.

ERCOLANIA, Trinchese.

Distr.—3 sp. Mediterranean.

Body subcylindrical; head small, without velum; foot narrow, with rounded anterior angles; branchiæ numerous, sprinkled with whitish globules; rhinophores long, graceful, very faintly canaliculate; anus in the middle of the back, in front of the heart.

PHYLLOBRANCHUS, Alder and Hancock.

Syn.—Lobifera and Polybranchia, Pease.

Distr.—5 sp. Ceylon, Red Sea, Philippines, West Indies, Medit. *P. orientalis*, Kel.

Near Hermæa; branchiæ leaf-like, with distinct foot-stalks; anus lateral; penis long, without sting.

STILIGER, Ehrenb.

Sny.—Calliopæa, Orb.

Distr.—5 sp. Red Sea, Europe, Massachusetts. *S. modestus*, Ehrenb.

Form of the body like that of Galvina; rhinophores simple, tentacles tuberculiform; dorsal papillæ club-shaped; foot rounded in front. Penis armed with a sting.

HERMÆA, Lovén.

Distr.—9 sp. Norway, Britain, etc. *H. dendritica*, Alder and Hancock (xci, 37).

Animal elongated, tentacles folded longitudinally; papillæ numerous, arranged down the sides of the back; sexual orifice below right tentacles; vent dorsal, or sublateral, anterior.

CYERCE, Bergh.

Distr.—2 sp. Pelew Islands. *C. elegans*, Semper.

Vent dorsal; foot transversely bipartite; penis short, armed with sting.

EMBLETONIA, Alder and Hancock.

Etym.—Dedicated to Dr. Embleton, of Newcastle.

Syn.—Pterochilus, A. and H.

Distr.—4 sp. Scotland (2 sp.). In the littoral and laminarian zones. *E. pulchra*, A. and H. (xci, 38).

Animal slender; tentacles two, simple; head produced into a flat lobe on each side; papillæ simple, subcylindrical, in a single row down each side of the back.

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Example.—*T. despectus*, Alder (xci, 39).

Tentacles subulate, smooth; branchiæ in a single row on each side, each with a sucker-like extremity; foot rudimentary. Spawn kidney-shaped.

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Distr.—*F. dubius*, DeKay.

Foot stunted; body slender; tentacles two; mouth on a loose fringe of skin with two small oral feelers; papillæ in two long rows down the back.

FAMILY ELYSIIDÆ.

Animal shell-less, limaciform, with no distinct mantle or breathing-organ; respiration performed by the ciliated surface of the body; mouth armed with a single series of lingual teeth;

stomach central, vent median, subcentral; hepatic organs branched, extending the length of the body and opening into the sides of the stomach; sexes united; male and ovarian orifices below the right eye; female orifice in the middle of the right side; heart with an auricle behind, and traces of an arterial and venous system, eyes sessile on the sides of the head, tentacles simple or obsolete.

SUBFAMILY *ELYSIINÆ*.

Body very flat; front narrow; tentacles short, mostly ear-shaped, the edges rolled up; eyes distant; genital orifice double, behind the right tentacle; sides of the back winged, and a peri-cardio-renal protuberance as in Placobranchus; surface of the back smooth, except an elevated line branching to the wings; pharynx and radula nearly as in Placobranchus, but usually no crop: penis without sting. The genera are arranged as follows:

ELYSIA, Risso.

Syn.—Actæon, Oken, not Montfort. Aplysiopterus, Chiaje.

Distr.—7 sp. Europe, Philippines, Pelew Islands. *E. viridis*, Mont. (xci, 40).

Head rounded; tentacles of moderate size; vent anterior, latero-dorsal, dorsal wings not much plaited, without bordering, not continuous on the neck.

TRIDACHIA, Desh. (Pterogasteron, Pease.) Wings much plaited and undulated, continuous in front; otherwise like Elysia. *E. crispata*, Orsted. West Indies.

THURIDILLA, Bergh. Head rounded, tentacles of moderate size, vent posterior, median. *E. splendida*, Grube. Adriatic Sea.

ELYSIELLA, Bergh. Head carinated at the sides; tentacles minute, conical. *E. pusilla*, Bergh. Pelew Islands.

ALLPORTIA, Tenison-Woods. Body expanded, thin, wholly flattened anteriorly and posteriorly; eyes submarginal. Tasmania.

DIPLOPELYCIA, Mörch, 1872.

Distr.—*D. trigonura*, Mörch. Mediterranean.

Body compressed as in Scyllæa; tentacles very strong, fan-shaped, festooned at the edge; no rhinophores, jaw or eyes; dorsal lobes with several fin-like processes; under sides keeled: with similar processes on each side; tail triangular.

SUBFAMILY *PLACOBRANCHINÆ*.

Body flat, front large, with short ear-shaped tentacles; eyes [illegible] the neck, approximate; double genital orifice near the right te[illegible] tacle; a distinct protuberance behind the neck, containing t[illegible]

kidney and pericardium, and with the vent on its right side; sides of the back produced in lateral wings, usually bent upwards; upper face of the back with parallel longitudinal folds; foot not distinctly separated from the rest of the body, transversely bipartite in front. Only genus—

PLACOBRANCHUS, Hasselt.

Distr.—9 sp. East Indies, Polynesia. *P. ocellatus*, Quoy (xci, 41).

Characters those of the subfamily.

SUBFAMILY *LIMAPONTIINÆ.*

Body slug-like, minute; head depressed, its sides carinated or produced into simple feelers; eyes separated; no dorsal wings; foot continuous; pharynx as in Elysia; plates of the radula somewhat compressed, with a carinated hook; penis armed with a sting.

LIMAPONTIA, Johnston.

Syn.—Chalidis, Quatref. Pontolimax, Cr.

Distr.—Norway, England, and France, between half-tide and high-water, feeding on Confervæ, in the spring and summer; spawn in small pear-shaped masses, each with 50–150 eggs; fry with a transparent nautiloid shell, closed by an operculum. *L. cærulea*, Quatr. (xci, 42).

Animal minute, leech-like; head truncated in front, with arched lateral ridges on which are the eyes; foot linear.

ACTEONIA, Quatrefages.

Distr.—2 sp. *A. senestra*, Quatr. (xci, 43).

Animal minute, leech-like; head obtuse, with lateral crests proceeding from two short conical tentacles, behind which are the eyes.

CENIA, Alder and Hancock.

Syn.—Fucola, Quoy.

Distr.—*C. Cocksii* (xci, 45).

Animal limaciform, back elevated, head slightly angulated, bearing two linear dorsal tentacles, with eyes at their outer bases behind.

RHODOPE, Kölliker, 1847.

Distr.—*R. Veranii.* Upon algæ, Messina.

Animal minute, similar to Limapontia (?); worm-shaped, rather convex above, flat beneath; without mantle, gills or tentacles. Probably not a mollusk.

FAMILY PHYLLIDIIDÆ.

Branchiæ covered or wanting.

SUBFAMILY *PHYLLIDIINÆ.*

Limaciform; the branchiæ leaf-like, between the mantle and the foot. No jaws or tongue.

PHYLLIDIA, Cuvier.

Etym.—Diminutive of *phyllon*, a leaf.

Distr.—6 sp. Mediterranean, Red Sea, India, Polynesia. *P. trilineata*, Cuv. (xci, 46).

Animal oblong, covered with a coriaceous tuberculated mantle; dorsal tentacles clavate, retractile into cavities near the front of the mantle; mouth with two tentacles; foot broadly oval; gills forming a series of laminæ extending the entire length of both sides; excretory orifice in the middle line, near the posterior end of the back, or between the mantle and foot; reproductive organs on the right side; stomach simple, membranous.

PHYLLIDIELLA, Bergh. Dorsal tubercles rounded and in quincunx order; vent dorsal; pharynx asymmetrical. 3 sp. Philippines, East Indies. *P. pustulosa*, Cuv.

PHYLLIDIOPSIS, Bergh. Vent dorsal, as in Phyllidia, tentacles soldered in their whole length to their basis, as in Doridiopsis. *P. cardinalis*, Bergh, Tonga.

FRYERIA, Grube.

Distr.—*F. pustulosa*, Rüppell (xci, 47). South Sea, East Africa.

Excretory orifice on the side of the foot under the mantle, which is leathery and watery; six gills entire length of both sides.

HYPOBRANCHIÆA, A. Adams.

Distr.—*H. fusca*, A. Ad. (xci, 48). Japan.

Mantle cuticular; gills limited to the hinder part of the body; excretory orifices at the side, under the mantle.

SUBFAMILY *PLEUROPHYLLIDIINÆ.*

Limaciform; branchiæ in a fold of the posterior margin of the mantle; tongue armed.

PLEUROPHYLLIDIA, Meckel.

Syn.—Diphyllidia, Cuvier. Linguella, Blainv. Armina, Raf. Dermatobranchus, Hasselt.

Distr.—14 sp. Norway, Britain, Mediterranean, India. *P. Cuvieri*, Meckel (xci, 49).

Animal oblong, fleshy; mantle ample; gills limited to the hinder two-thirds of the body; head with minute tentacles and a lobe-like veil; vent at the right side, behind the reproductive orifices; lingual teeth 30·1·30.

SANCARA, Bergh.

Distr.—2 sp. Mediterranean, Japan.

Mantle smooth, not distinctly separated from the body anteriorly; no caruncula tentacularis.

CAMARCA, Bergh.

Distr.—1 sp. Realejo, Central America.

Caruncula tentacularis low, united with the front of the mantle; this latter without urticating organs.

SUBFAMILY *PLEUROLEURINÆ.*

Without gills.

PLEUROLEURA, Bergh.

Distr.—*P. ornata*, Bergh. Philippines.

Near Pleurophyllidia, but wanting the gills; tentacular shield without caruncles; back broad, its lateral edge with numerous urticatory pores; jaws like those of Pleurophyllidia, but without masticatory process, and with a smooth edge.

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STRUCTURAL

AND

SYSTEMATIC

CONCHOLOGY:

AN INTRODUCTION TO THE STUDY OF THE

MOLLUSCA.

VOL. III.

By GEORGE W. TRYON, Jr.

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CONCHOLOGY.

SUBCLASS PULMONATA.

This division embraces all the land and fresh-water mollusca which breathe air. They are normal gastropods, having a broad foot, and usually a large spiral, holostomate, inoperculate shell (operculate in Amphibola). Their breathing organ is the simplest form of lung, resembling the branchial chamber of the sea-snails, but lined with a network of respiratory vessels. The respiratory orifice is small and contractile to prevent too rapid desiccation in the land-snails, and to exclude water in the aquatic genera. Most of them have sufficiently large shells to contain the animal; in a few the shell only shelters a portion of the animal, or it is internal and of simple structure, or rarely absent. Snail-shells contain a larger proportion of animal matter than sea-shells, and their structure is less distinctly stratified. The Pulmonata are mostly terrestrial, but some genera are fluviatile and a few inhabit damp places near the sea, where at high-tide they are covered by its waters. The sexes are united in each individual, but the genital orifices are sometimes contiguous, opening in a common cloaca, and sometimes distant. Through the Cyclostomæ or operculated land-snails and the Ampullariæ they are related to the phytophagous sea-snails, through Siphonaria and Gadinia to the limpets, and through Onchidium to the nudibranchs.

Land-snails are universally distributed; but the necessity for moist air, and the vegetable nature of their food, favor their multiplication in warm and humid regions: they are especially abundant in islands, whilst in hot and desert countries they appear only in the season of rain or dews. Their geological history is less complete than that of the purely marine orders; but their antiquity might be inferred from the distribution of peculiar genera in remote islands, associated with the living representatives of the ancient fauna of Europe. Fresh-water snails

(Limnæidæ) occur in the English Wealden, but fossil land-snails have not been found in strata older than the tertiary in Europe, and then under forms generically, and even in one instance specifically, identical with living types of the New World (Megaspira, Proserpina, Glandina, and Helix labyrinthica).— *Woodward.*

The oldest American fossils of this subclass occur in the Carboniferous.

The lingual dentition of the Pulmonata confirms, in a remarkable manner, those views respecting the affinities of the subclass, and its zoological value, which have been deduced from the more obvious characters afforded by the animal and shell. They have, without known exception, rows of very numerous, similar teeth, with broad bases, resembling tessellated pavement. Their crowns are recurved, and either aculeate or dentated. The lingual ribbon is very broad, often nearly as wide as it is long; and the number of teeth in a row (though usually a third less) is sometimes as great, or even greater, than the number of rows. The rows of teeth are straight or curved or angulated; when the rows are straight the teeth are similar in shape; curves indicate gradual changes, and angles accompany sudden alterations of form.— *Woodward.*

The jaw is single, or is composed of three pieces, never of two pieces as in the branchiferous snails.

In the young snails the temporary vellum is rudimentary or absent, with the exception of the maritime genera, in which it is well-developed. The first development of the shell, at least in Limax, Clausilia and Helix, is within, instead of on the exterior surface of the mantle as in the other gastropods. It is similar in most cephalopods, but in these the shell continues internal, whilst in most of the pulmoniferous genera it becomes external at an early period.

The Pulmonata are conveniently divided into the orders :—

1. Stylommatophora (Geophila, Ads. Nephropneusta, Ihering).—Eyes at the ends of the superior tentacles.

2. Basommatophora (Branchiopneusta, Ihering).—Eyes at the base of the tentacles.

Order STYLOMMATOPHORA.

Terrestrial mollusks having four tentacles, the superior pair invaginate or retractile, oculiferous at their extremities. They may be divided into Monotremata and Ditremata, according to the union or separation of the sexual openings.

Suborder *MONOTREMATA.*

Male and female orifices united; oculiferous tentacles invertible.

* *Agnatha.* Mouth without jaw; generally no median tooth in the radula; lips often developed into feeler-like appendages; neck commonly elongated, and peculiarly furrowed on the back.

FAMILY TESTACELLIDÆ.

Animal slug-like, bearing a small ear-shaped shell near the posterior extremity of the body. No jaw. Lingual teeth long and narrow, sharp-pointed, in oblique series.

TESTACELLA, Cuvier, 1800.

Etym.—Diminutive of *testa*, a shell.
Syn.—Helicolimax, partim, Fer., 1807. Testacellus, Faure-Biguet, 1801.
Distr.—17 sp. Europe, Canary Islands. Fossil, 2 sp. European tertiary. *T. haliotidea*, Fer. (c, 42; ci, 44).

Animal limaciform, subcylindrical, tapering anteriorly; tentacles simple; mantle small, posterior, quite near the tail, covered with a small external shell; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; no distinct locomotive disk; external respiratory and anal orifice at the posterior right edge of the mantle under the peristome of the shell; combined generative orifice behind and below the right eye-peduncle.

Shell external, rudimentary, imperforate, ear-shaped, with a subspiral, posterior nucleus.

"The Testacella is one of the few land-mollusks with true predaceous habits; its marine representatives in this respect being the cuttle and the whelk. It is scarcely inferior to the tiger, snake or shark in its cunning and ferocity. Its prey chiefly consists of earth-worms, which it hunts underground and pursues through their galleries, crouching occasionally and making a spring on its victim. It is said that when the poor worm has had the start of its pursuer, the snail-slug intercepts it by tunneling across the line of its retreat. It will devour a lob-worm much longer than itself, seizing it in the middle; and when the writhings have been succeeded by exhaustion, it detaches and swallows one-half of the worm; and after that has been digested it finishes its long meal with the other portion. For this purpose its mouth is furnished with an apparatus of sharp recurved teeth, which enables the Testacella to retain a firm hold of its victim and swallow it more easily. The worm is provided with some means of defense, in the rows of stiff bristles which encircle its rings; and by contracting its body a short respite is occasionally gained. But the chance of ultimate escape or safety is very slight. When the Testacella sees or scents its prey, it glides softly and cautiously towards it; and, apparently without taking any notice of the worm, it seems to feel its way, and usually succeeds in fastening itself on an unprotected part of the body between the rings. The attack, if unsuccessful at first, is renewed; but if the worm resists too long, the Testacella gets impatient, and by pressing or doubling its victim into the earth, by which

means the rings are forced open, its purpose is effected and the meal secured.

"Although it also feeds on slugs and snails, and even on its own species (the shells of which have been found in its stomach), it will not eat dead animals, and even refuses pieces of a fresh worm which has been chopped up to feed it. It only sallies out at night in search of its prey, burying itself deep in the ground during the daytime. After having gorged itself with a worm, it rests many hours in a half-torpid state until the meal has been digested; and it can remain fasting a long time (as much as fourteen or fifteen nights), until hunger compels it to make a fresh hunt. It does not fear the cold, or appear to suffer any inconvenience from it except when the ground is hardened by frost; and in this respect it resembles the slugs, the Vitrinæ, and some of the Zonites, some of which are nearly as carnivorous and hardy as the Testacella. The average length of life in the Testacellæ appears to be five or six years. Their smell is like that of worms, only more nauseous. They chiefly frequent gardens, where they are sure of finding their proper food; but they may occasionally be met with in woods near inhabited places, as well as at the foot of old walls. In winter they bury themselves very deep in the ground; and my gardener once brought me living specimens of *T. Maugei* which he had dug up in trenching some celery-roots at a depth of about two feet. The eggs are laid separately and are very large in proportion to the size of the body. These somewhat resemble hens' eggs both in shape and consistency, and are covered with a rather thick and tough skin. If they are taken out of the earth and exposed to a cold air, they frequently crack and burst in pieces which fly off to some little distance."—*Jeffreys' Brit. Conchology.*

During winter and dry weather the Testacella forms a sort of cocoon in the ground by the exudation of its mucus. If this cell is broken, the animal may be seen completely shrouded in its thin opaque white mantle, which rapidly contracts until it extends but a little way beyond the margin of the shell. It was introduced into Great Britain, where it is becoming common.

DAUDEBARDIA, Hartmann, 1821.

Etym.—Dedicated to Daudebard de Ferussac, a celebrated French conchologist. *Syn.*—Helicophanta, Fer., 1822.

Distr.—13 sp. Central and eastern Europe, Algiers, New Zealand. *D. Gaillardotii*, Bourg. (ci, 45, 46). Syria.

Animal limaciform, subcylindrical, tapering anteriorly; tentacles simple; mantle small, posterior, quite near the tail, covered with a small, external shell; longitudinal furrows above the margin of the foot; usually no caudal mucous pore; external respiratory and anal orifice at the posterior right margin of

mantle, under the peristome of the shell. Predaceous, devouring small Helices, Vitrina and Clausilia.

Shell small, external, perforate, depressed; paucispiral, whorls rapidly increasing.

RUFINA, Clessin. Shell umbilicated. *D. rufa*, Drap.

PSEUDOLIBANIA, Stefani. Shell haliotiform, spire very short, narrowly rimate, columellar lip slightly reflected over the umbilical slit. *D. Langi*, Pfr.

LIBANIA, Bourg. Umbilicus covered in the adult. *D. Saulcyi*, Bourg.

ISSELIA, Bourguignat. Shell perforated. Animal with caudal mucous pore. *D.* (*Helicarion*) *Sardous*, Issel.

CHLAMYDOPHORUS, Binney, 1879.

Distr.—*C. Gibbonsi*, Binney (ci, 47). Natal.

Mantle covering the whole body, with an orifice on the centre of the back near the tail, enclosing at the same part a solid internal shelly plate; no caudal mucous pore; no jaw; teeth as in Glandina. Position of the genital orifice unknown.

PLECTROPHORUS, Fer., 1819.

Distr.—5 sp. Teneriffe. *P. Orbignyi*, Fer. (ci, 48).

Animal elongated, subcylindrical, with a tough dorsal anterior integument or mantle, under which is the pulmonary cavity, having its orifice on the right side, with the anal orifice near it; there is a second long and narrow posterior mantle, and an external rudimentary conical, non-spiral shell near the posterior extremity; upper tentacles longest, oculiferous, retractile.

This animal has not been recognized; the doubly armored back and conical external shell are both improbable characters.

SELENOCHLAMYS, Böttger, 1883.

Distr.—*S. pallida*, Böttg. Caucasus.

Animal resembling Daudebardia, but without a shell; mantle small, the surface divided by longitudinal sulcations; tail short, compressed, carinated; foot narrow, tripartite.

FAMILY OLEACINIDÆ.

Shell fusiform, corneous, more or less transparent, rarely banded longitudinally; aperture longitudinal, narrow; columella twisted or truncated at its base. Lingual teeth numerous, in more or less curved, transverse rows, the central teeth inconspicuous, the marginal aculeate, or with a single, long, recurved apex (xiii, 56, 57). Head short, with a retractile, often produced, buccal sac; eyes at the tips of elongated, cylindrical, retractile peduncles; inferior tentacles moderate, situated below the eye-peduncles; foot elongate, narrow, simple posteriorly.

Living in humid situations; carnivorous.

STREBELIA, Crosse and Fischer, 1868.

Syn.—Physella, Pfeiffer, 1861 (not Hald., 1842). Spirobulla, Ancey, 1881.

Distr.—1 sp. Mexico. *S. Berendti*, Pfeiffer (xcii, 50).

Shell bulliform, spire very short, the last whorl elongated, comprising nearly the entire length of the shell; columella simple, arcuated, not truncate; peristome simple, acute. Animal much larger than the shell.

OLEACINA, Bolten, 1798.

Syn.—Cochlicopa, Fer., 1819. Pfaffia, Behn., 1844.

Distr.—142 sp. U. S. (Gulf States), West Indies, Mexico, Central American, Northern South America, So. Europe (one species), Algiers. Fossil. Cret.—; Europe.

Shell oval-oblong, with a thin, smooth olivaceous epidermis; last whorl large, sometimes attenuated at the base; aperture elliptical-oblong, equaling or exceeding half the length of the shell; outer lip simple, sharp, usually somewhat inflected in the middle.

VARICELLA, Pfeiffer, 1855. Shell with longitudinal varices. *O. leucozonias*, Walch.

MELIA, Albers, 1850. Shell fusiformly turreted, longitudinally subcostate; whorls rather flattened; columella twisted, obliquely truncate; aperture narrow, semioval; lip simple, submarginate within. *O. simplex*, Strebel.

BOLTENIA, Pfeiffer, 1878. Typical group of Oleacina. *O. oleacea*, Fer. (xcii, 51). Cuba.

POIRETIA, Fischer, 1883. Animal with feebly developed labial palpi. Formed for *O. Algira*, Brug., the only European species.

GLANDINA, Schum., 1817. (Polyphemus, Mont., 1810. Euglandina, Crosse and Fischer, 1870.) Shell oblong-oval, fusiform, corneous, covered by a thin, fugacious epidermis; spire more or less elevated, of six or eight whorls; columella thin, arcuated, truncated at base; aperture rather narrow, longitudinal; lip sharp, simple.

Animal much longer than the shell, when extended; oculiferous tentacles deflected at the tips, beyond the eyes; inferior tentacles much shorter, also deflected; lips elongated, tentacular (vi, 72). *O. Carminensis*, Morelet (xcii, 52). *O. truncata*, Gmel. (xcii, 53). Florida. These animals are predaceous in their habits, and carnivorous; they attack with avidity Bulimi as large as themselves, and devour them. When they have chosen a victim they probe the aperture with their palps before penetrating it; the buccal mass is then protruded, and the contents consumed through the aperture they make. The species inhabit tropical America—mainly Mexico and Central America, although a few species occur in the southern United States. The shells are of larger size

than the other groups of the genus, in some species attaining a length of three inches.

SELASIELLA, Strebel, 1878. Shell very small, glossy, vertically striated; columella truncated; labial palpi wanting. The stomach is simple as in Streptostyla (but is double in Glandina). 3 sp. Mexico. *O. perpusilla*, Pfeiffer.

[PSEUDOSUBULINA, Strebel and Pfeffer, 1882.

Distr.—Mexico. *P. Chiapensis*, Pfeiffer.

Shell turriculated, whorls numerous, narrow, the last much smaller than the others; columella truncated at the base; peristome simple.

Animal without jaw.

VOLUTAXIS, Strebel and Pfeffer, 1882. Columella with a basal plication. *Spiraxis Berendti*, Pfeiffer. Mexico.

The shells resemble Subulina and Spiraxis, but the animal has no jaw.]

STREPTOSTYLA, Shuttleworth, 1852.

Distr.—49 sp. Tropical America, West Indies.

Shell oval-oblong, subcylindrical, the last whorl proportionally very large, cylindrical; aperture elongated, narrow behind; outer lip simple, inflected in the middle; columella with a thickened fold at the base.

Animal: tentacles but slightly developed, labial palpi moderate, foot short.

The texture and general form of the shell do not much differ from some species of Oleacina, but the genus is at once distinguished by its columellar fold, instead of the truncation of Oleacina.

STREPTOSTYLA (restricted). Shell longitudinally striated. *S. Nicoleti*, Shuttl.

CHERSOMITRA (Shuttleworth), Albers, 1860. Shell cylindrical, smooth, shining, usually yellowish; aperture more than half the length of the shell; outer lip distinctly inflected. Mexico, Guatemala. *S. Delattrei*, Pfr. (xcii, 54). Central America.

PETENIA, Crosse and Fischer, 1868. Distinguished by the presence of a muciparous pore at the end of the foot; tentacles and buccal lobes as in Glandina; foot truncated behind. Spire lengthened; columella twisted. *S. ligulata*, Morelet.

FAMILY STREPTAXIDÆ.

Shell heliciform or pupiform, often with the last whorls obliquely deviating.

Animal with a long neck and short tail; superior tentacles long, narrow; labial palpi narrow, moderate.

STREPTAXIS, Gray, 1837.

[illegible] Beck. 1837.

[illegible] Mostly South American; Africa: East Indies.
[illegible] form but often oblique, profoundly umbili[illegible] enlarging, deviating from the original [illegible] aperture lunar, with or without teeth; lip [illegible] reflected.

[illegible] character of the group is found in the singular [illegible] whorls causing a torsion of the axis of [illegible]

[illegible] 1855. (Epistylia, Pfr., 1877.) Aperture [illegible] subregular. American. *S. candidus*, Spix.
[illegible] Shell similar to that of Hyalina. Front [illegible] elongated; teeth of the radula dagger-shaped, [illegible] rhombic. *S. Semperi*, Döring. Argen[illegible]

[illegible] Pfeiffer. 1855. Shell depressed orbicular, [illegible] thin, radiately striate; umbilicus wide, per[illegible] rather flattened; last whorl not descending at [illegible] periphery rounded; aperture large, rounded [illegible] acute, its extremities approaching. *S. omo*[illegible]

[illegible] Pfeiffer, 1855. Shell conoidal or discoidal; [illegible] outer lip armed with teeth. *S. discus*, Pfr.
[illegible] Pfeiffer, 1877. Typical group. *S. contusus*, [illegible] *S. [illegible]mboides*, d'Orb. (xcii, 56). *S. deformis*, Fer.

[illegible] Pfeiffer, 1855. Shell ovate: parietal wall and [illegible] armed with teeth. *S. bulbulus*, Morelet.

OMPHALOPTYX, Böttger, 1875.

[illegible] Hesse. *O. supracostata*, Böttger. Fossil.
Shell [illegible]iform, subperforated, conical and costulated above, [illegible] below; last whorl very large, a little contracted at the [illegible] aperture small, a little oblique, semilunar; outer lip [illegible] sharp; columella thickened at the base, reflected over [illegible] umbilical perforation; parietal wall with a horizontal plica[illegible] Is supposed to be related to Streptaxis.

ENNEA, H. and A. Adams, 1855.

[illegible] sp. Africa, Mauritius, Madagascar, India, etc.
E. [illegible], Lea (xcii, 58). Liberia.
Shell subcylindrical, slightly rimate, apex obtuse, smooth, [illegible] hyaline; whorls flattened, the last narrow, sulcate [illegible] in the middle, lamellate within, with a strong plait [illegible] to the columella; aperture subcircular; parietal lamella [illegible] inwards and situated close to the right margin;

peristome expanded, the right margin flexuous, thickened in the middle.

EDENTULINA, Pfeiffer, 1855. Peristome not toothed. *E. ovoidea*, Brug.

ELMA, H. Adams. A strong sinus at the outer lip; aperture edentulous. *E. Swinhoei*, H. Adams. Formosa.

GONAXIS, Taylor. Shell pupiform, axis of the apical whorls diverted to the right.

UNIPLICARIA, Pfeiffer, 1855. Parietal margin lamellate; outer lip edentulous. *E. cerea*, Dunker (xcii, 59). Madagascar.

ENNEASTRUM, Pfeiffer, 1855. Parietal and outer margins of aperture both lamellate. *E. elegantula*, Morelet.

GULELLA, Pfeiffer, 1855. Shell ovate, parietal margin lamellate, outer lip multidentate. *E. capitata*, Gould (xcii, 60). E. Africa.

PTYCHOTREMA, Mörch, 1852. (Cyclodontina, Beck, 1837.) *E. Guineensis*, Beck.

HUTTONELLA, Pfeiffer, 1855. Shell cylindrical, parietal margin plicate; outer lip quadridentate. *E. Kraussi*, Pfeiffer.

DIAPHORA, Albers, 1850. Cylindrical, umbilicated, apex obtuse, base obsoletely carinate; whorls ten, flattened, the last detached; aperture pyriform, with slightly expanded lip. 2 sp. Indo-China, Philippines. *E. Cylindrelloidea*, Stol.

STREPTOSTELE, Dohrn, 1866.

Distr.—4 sp. Prince's Isl., Africa. *S. Nevilli*, H. Adams (xcii, 61). Seychelles.

Shell of the form of Achatina, but hyaline as in Streptaxis and Ennea; pillar-lip short, twisted and thickened. Color of the animal intensely red or yellow, as in the two last-named genera.

GIBBULINA, Beck, 1837.

Syn.—Gibbus, H. and A. Adams, 1855.

Distr.—43 sp. Mauritius, Isle of France, Madagascar, Seychelles.

Shell corneous or white, solid, calcareous, pupiform or turbinate, summit obtuse; last whorl gibbous, sometimes angulated and deformed; umbilicus large, not deep; lip reflected, its extremities united by a callus; columella sometimes plicate.

GIBBUS, Montf., 1810. Shell subconical, whorls irregular, laterally compressed. *G. Lyonettiana*, Pall. (xcii, 62). Isle of France.

GONIODOMUS, Swains., 1840. (Idolum, Pfeiffer, 1855.) Ovate, ventricose, obliquely costulate. *G. pagoda*, Fer. (xcii, 63). Mauritius.

PLICADOMUS, Swains., 1840. Spire moderate, subconic, obtuse; outer lip reflected; surface obliquely costulate. *G. sulcata*, Müll. (xcii, 64). Mauritius.

GONOSPIRA, Swainson, 1840. (Gibbulina, Pfr., 1855.) Typical group. *G. palanga*, Fer. (xcii, 65). Isle of France.

NEVILLIA, Martens. Whorls narrow, with strong perpendicular ribs. 3 sp. Mauritius. *G. clavulata*, Lam.

Ravenia, Crosse, 1873.

Distr.—*R. Blandi*, Crosse (xcii, 66). Curaçao.

Shell allied to Spiraxis and Pupa, turreted, imperforate, subhyaline, columellar margin spirally twisted, outer margin bent inwards, and with a strong tooth in the middle.

Family HELICOIDEA.

Shell heliciform, with usually depressed conical spire, and umbilicated; outer lip simple.

Animal differing from the true Helices by the absence of a jaw.

Rhytida, Albers, 1860.

Distr.—31 sp. Australia, Tasmania, New Caledonia, etc. *R. bullacea*, Pfr. (xcii, 67). Australia.

Shell umbilicate, thin, convexly depressed; undulately rugose or striate; spire slightly elevated; whorls four or five, slightly flattened; umbilicus wide and deep; aperture oblong-ovate, sometimes dentate within; lip simple, acute, its extremities approaching.

Viviparous. Teeth rather few, oblique, arcuated.

DIPLOMPHALUS, Crosse and Fischer, 1873. Shell discoidal, planorbiform, spire depressed; peristome simple, connected by a much-developed parietal callus. 13 species. New Caledonia, New Zealand, Australia. *D. Megei*, Lamb. (xciii, 68, 69). N. Caledonia. Differs from Rhytida by the very wide umbilicus and sunken excavation of the upper face of the shell; in the radula by the equal size of the lateral teeth.

Guestieria, Crosse, 1872.

Distr.—*G. Powisiana*, Pfr. New Grenada.

Shell imperforate, corneous, thin, depressed, quite involute, the last whorl only visible; aperture like that of Nautilus; peristome thin, simple. Animal unknown.

Aerope, Albers, 1860.

Distr.—*A. caffra*, Fer. So. Africa.

Shell very thin, subglobose, costulately striate, with narrow umbilicus; spire not prominent, obtuse; whorls four, ventricose, strongly striated, the last descending at the aperture; aperture large, semiovate; lip simple, acute; columellar margin widely reflected.

Teeth very long, subulate, arranged in converging lines.

PARYPHANTA, Albers, 1850.

Distr.—New Zealand, Australia. *P. Busbyi*, Gray (xciii, 82). Shell widely umbilicated, depressed, covered by a thick, shining, coriaceous epidermis, enveloping the peristome; aperture oblique, semilunar; peristome simple.

** *Gnathophora*. Mouth with jaw. Modern malacologists have arranged the families of this division of the Pulmonata in accordance with the structure of the jaw, and to a certain extent this accords with the arrangement by external characters—mainly of the shell. I adopt

† *Holognatha*. Jaw simple, without superior appendage. Helices, Bulimi, Cylindrellæ, Pupæ, Limaces, etc.

†† *Elasmognatha*. Jaw with a superior quadrangular accessory plate. Succineæ.

† *Holognatha*.

Includes, as shown above, most of the terrestrial pulmonates. A further division has been attempted according to the ornamentation of the jaw, but the number of observations made upon this organ are not sufficiently numerous to justify a classification in accordance therewith; particularly as the groupings heretofore effected are often in disaccord with obvious relations of the shell.

The arrangement followed in these pages is mainly that of Pfeiffer's "Nomenclator Heliceorum Viventium," but with some modifications and additions. The naked snails I have preferred to interpose between the Helices and Succineæ, as proposed in Gill's Classification (vol. i, 266), rather than preceding the Helices, as in Fischer.

I give herewith the names and descriptions of the proposed divisions of the Holognatha, founded upon jaw characters, with the principal genera which have been referred to each. Upon the value of these characters, see Binney's remarks (vol. i, 261).

I. *Oxygnatha:* Jaw smooth, edge cutting, often with a median prominence. Philomycus, Limax, Tennentia, Parmacella, Helicarion, Ariophanta, Nanina, Rhysota, Vitrina, Hyalinia, Zonites, Leucochroa, Rumina, Clausilia; perhaps also Phania, Planispira, Solaropsis, Otala, Caracolla, Labyrinthus.

II. *Aulacognatha:* Jaws finely and regularly grooved, edge crenulated. Ena, Pupa, Discus, Vallonia; perhaps also Sagda and Hygromia (Fruticola).

III. *Stegognatha:* Jaw finely plicated; the plications imbricated, parallel or oblique to the centre. Punctum, Bulimulus.

IV. *Odontognatha:* Jaw strongly ribbed, edge toothed. Veronicella, Arion, Ariolimax, Anadenus, Pellicula, Peltella, Moreletia?, Pfeifferia, Chloræa, Axina, Pythohelix, Helicobulimus, Cochlicellus, Jacosta, Euparypha, Eulota, Triodopsis, Trigonostoma,

Arionta (including Chilotrema and Campylæa), Iberus, Tachea, Pomatia, Pleurodonta, Thelidomus, Limicolarius, Achatina, Borus.

V. *Goniognatha:* Jaw composed of several pieces, joined together in oblique lines. Pseudostrombus [= Lignus], Orthalicus.

Family VITRINIDÆ.

Animal with or without mucous caudal pore, tail often obliquely truncate; mantle-margin sometimes more or less produced, or reflexed over the sides, or entirely covering the shell, which the animal is too large to entirely enter.

Shell usually thin, corneous, transparent, spiral, of few, rapidly enlarging whorls.

Vitrina, Drap., 1801.

Syn.—Helicolimax, Fer., 1821. Cobresia, Hübner, 1810. Limacina, Hartmann, 1821. Parmacellina, Sandberger.

Distr.—93 sp. Universal. Mostly inhabit cold or temperate countries or mountain regions of warm countries. Fossil. Eocene of Europe.

Shell imperforate, very thin, depressed; spire short, last whorl large; aperture large, lunate or rounded, columellar margin slightly inflected, peristome often membranous.

Animal elongated, too large for complete retraction into the shell; tail very short; mantle reflected over the shell-margin, and furnished with a posterior lobe on the right side; without a caudal mucous pore. Lingual plate with central tooth tricuspid, laterals bicuspid; marginals acuminated, slim, bicuspid. Occasionally animal-feeders, like the slugs.

They live in moist situations, among loose earth, stones, grass and moss. They are very lively, crawling constantly about, and when touched will sometimes jump several inches from the ground.

OLIGOLIMAX, Fischer. Shell small, sculptured, minutely perforate. Mantle not much extended beyond the shell in front. Animal contractile within the shell. *V. annularis*, Studer. Europe.

SEMILIMAX, Stabile, 1859. Animal not able to withdraw entirely within its shell; shell imperforate. *V. diaphana*, Drap.

PHENACOLIMAX, Stabile, 1859. Animal capable of withdrawing entirely within its shell, and forming a vitreous epiphragm. *V. major*, Fer. (xcii, 70). Europe. *V. fasciata*, Soul. (xcii, 71, 72). Philippines.

GALLANDIA, Bourguignat. (Trochovitrina, von Martens.) Spire conical, last whorl more or less angular, umbilicus perforated. Animal wholly retractile within the shell. *V. Lederi*, Böttger. 3 sp. Caucasus, Turkestan.

VITRINOZONITES, Binney.

Distr.—*V. latissima*, Lewis. Tennessee.

Shell like Vitrina. Animal having a caudal mucous pore with longitudinal furrow; no appendiculate mantle-process; marginal teeth of radula simple, not bifid.

VELIFERA, Binney.

Distr.—*V. Gabbi*, Binney. Costa Rica.

Shell as in Helicarion. Animal: mantle with one or more accessory processes which cover most of the shell; a simple longitudinal mucous pore, without horn-shaped process; jaw with smooth anterior surface, and beak-like projection on the cutting edge; radula resembling Zonites.

PARMELLA, H. Adams, 1867.

Distr.—*P. planata*, H. Ad. (xcii, 79). Fiji Isles.

Animal undescribed. Shell depressed, spire flat, epidermis horny, polished, extending greatly beyond the posterior part of the margin.

VITRINOIDEA, Semper, 1873.

Distr.—*V. Albaiensis*, Semper. Philippines.

Shell wholly concealed by the mantle, with cuticle and calcareous layer, forming several whorls; respiratory orifice before the middle of the mantle; no caudal mucous pore; marginal teeth of the radula three-pointed; jaw smooth; accessory glands at the genital organs; no flagellum.

VITRINOPSIS, Semper, 1870.

Distr.—2 sp. Philippines. *V. tuberculata*, Semper.

Two lobes of the mantle covering a part of the shell in front and on the left side, not on the right as in Vitrina. Lateral teeth of the radula three-pointed, not 1–2 pointed as in Vitrina.

VITRINOCONUS, Semper, 1873.

Distr.—9 sp. Philippines. *V. cyathus*, Pfeiffer.

Shell umbilicated, conical or trochiform, apex obtuse; whorls planulate, the periphery carinate or angulate; aperture lunate; peristome simple, acute or thickened.

Mantle sometimes with cervical lobes, but no shell-lobe; lateral teeth of the radula two-pointed.

LACONIA, Gray, 1855.

Distr.—1 sp. *L. Ferussaci*, Gray.

Body subglobose; mantle edged, produced in front, forming a broad collar.

Shell subglobose, entirely and permanently covered by a thin expansion of the mantle; spire of few whorls, the last very large; aperture very large, lunate.

HELICARION, Fer., 1821.

Syn.—Austenia, Nevill. ? Hoplites, Theobald, 1864.

Distr.—95 sp. India, East Indies, Philippines, Australia, Abyssinia. *H. flammulata*, Quoy (xcii, 77). Celebes.

Shell heliciform, rounded-oval, thin, fragile, covered with a very light epidermis; spire short, whorls few, the last much swollen; aperture large, oblong-triangular; peristome simple, sharp.

Animal not entirely retractible within the shell; mantle produced in front into two lobes upon the neck, and posteriorly, on the right side into a lobe partly covering the shell; foot truncated behind, the sole divided longitudinally into three parts.

ZONITARION, Pfeffer, 1883. Jaw without middle tooth. *H. semimembranaceus*, von Martens.

OTESIA, H. and A. Adams. (Vitrinella, Gray.) Mantle-lobe covering the greater part of the shell. Shell imperforate, very thin, spire conic.

FAMILY ZONITIDÆ.

Animal able to withdraw completely within its shell; provided with a caudal mucous pore. Jaw produced in the middle. Lateral teeth bicuspid, marginals acuminate, unicuspidate or bicuspidate.

Shell usually depressed heliciform, umbilicated, thin, more or less transparent, with simple, sharp peristome.

The hyaline structure of the shell and the acute margin of the aperture most readily distinguish these shells from the Helicidæ, with which they are usually confounded.

ZONITES, Montfort, 1810.

Syn.—Archæozonites, Sandb.

Distr.—Europe and America. Fossil. Tertiary.

Shell subdepressed, umbilicated, very thin, more or less transparent; aperture semilunar, usually without teeth; lip thin, sharp.

Animal elongated, completely retractile within the shell; jaw with a well-marked middle rostrum, lateral teeth bicuspid, marginals unicuspid, sharp; foot with caudal mucous pore or slit. The Asiatic group Ariophanta has a similar shell, but the mantle-lobes are reflected upon it.

ZONITES (restricted). (Ægopis, Fitzinger, 1833. Tragomma, Held, 1837. Helicodes, Dumas, 1847. Verticillus, Moquin-Tandon, 1855.) Labial palpi small; caudal gland reduced to a simple groove, shell depressed orbicular, widely umbilicated; striated above, smooth below; lip sharp, with a slight callus on the parietal wall. Southern Europe, Asia Minor. 12 sp. *Z. Algirus*, Linn. (xciii, 92).

STENOPUS, Guilding, 1828. (Guppya, Mörch, 1867. Habroconus, Crosse and Fischer, 1872.) Animal with a narrow locomotive disk, and a border on either side, as in Vaginula; caudal gland with a retractile appendage. Shell perforated, conical or depressed, thin, diaphanous; peristome simple. 5 sp. St. Vincent, W. I., Mexico, Venezuela. *S. cruentatus*, Guild (xciii, 91). St. Vincent, W. I.

OMPHALINA, Rafinesque, 1819. (Moreletia, Gray, 1855. Edusa, Albers, 1860. Zonyalina, von Martens, 1865.) Shell widely umbilicated, striated above, smooth below. Labial palpi large, caudal pore well developed. 14 sp. United States, Mexico, Guatemala. *Z. fuliginosus*, Griffith (xciii, 96). U. S. Zonyalina is said to be distinguished from Moreletia by the want of the outer cervical lobe of the mantle.

MESOMPHIX, Rafinesque, 1819. Shell umbilicated or perforated, globosely depressed, thin, striated, reddish horn-color, lighter below, shining; whorls four-and-a-half to six; aperture lunar ovate; peristome simple, straight, acute, extremities approaching, that of the columella subreflexed. *Z. ligerus*, Say (xciii, 97). Several species, mostly United States. Barely distinguished from Omphalina by a more elevated spire.

ÆGOPINA, Kobelt. (Retinella, Shuttl.) Proposed for *Z. olivetorum*, Gm. (xciii, 95), and allied European species, scarcely distinct from the North American group Omphalina.

HYALINIA, Agassiz, 1837. (Aplostoma, Moquin-Tandon, 1855.) Shell depressed or conical, more or less longitudinally, but not spirally striate; semitransparent, smooth and shining; umbilicus large, rarely small or none; epiphragm none, rudimentary or vitreous. Flagellum none or short, thick and steadied by a terminal muscle; mucous vesicles represented by a glandular layer. 50 sp. Mostly Europe and North America. *Z. cellarius*, Müller.

VITREA, Fitz., 1853. (Crystallus, Lowe, 1854.) Shell small, fragile, shining, hyaline, smooth, convexly depressed, perforate or imperforate; whorls 4–6, the last not deflected at the aperture; aperture lunate, the lip simple, acute. Europe. *H. crystallina*, Müll.

POLITA, Held, 1837. (Oxychilus, Fitz., 1833. Lucilla, Lowe, 1854. Aplostoma, Moquin-Tandon, 1855. Euhyalina, Albers, 1857. Hyalina (restricted), Albers, 1860.) Shell convexly depressed or subdiscoidal, umbilicate, smooth, shining, pellucid, corneous, the base more or less milky opaque; aperture obliquely lunate; lip simple, acute. Mostly European. *H. glabra*, Stud.

ZONITOIDES, Lehm., 1864. *H. nitida*, Müll. Europe, United States.

NAUTILINUS, Mousson, 1872. Shell nautiloid, involute. *H. Clymene*, Shuttl.

CONULUS, Fitz., 1833. (Trochiscus, Held, 1837. Petasia, Beck, 1837.) Shell small, pellucid, corneous, globosely turbinated, or conic, thin, perforate or imperforate; aperture lunar, oblique; peristome simple. Universal, including several American and European species. *Z. fulvus*, Drap. (xciii, 98).

CONULOPOLITA, Böttger. No umbilicus as in Conulus. *H. Raddii*, Böttger. Caucasus.

GASTRODONTA, Albers, 1850. Shell subperforate or umbilicated, orbicularly depressed, light horn-color, sometimes glassy, with more or less numerous wrinkle-like striæ; whorls 5–7; aperture lunate, its base generally furnished with fold-like denticles not reaching its margin; peristome simple, acute. United States. *Z. interna*, Say (xciii, 100).

VENTRIDENS, Binney and Bland, 1869. Shell small, subperforated or umbilicated, orbicular, convex; aperture lunar, with revolving pliciform teeth within the base; peristome simple, sharp. *Z. gularis*, Say. *Z. suppressa*, Say. United States.

ODONTOSAGDA, Albers, 1860. Shell umbilicated, depressed, thin, white; whorls six, the last with convex base; aperture somewhat oblique, lunar, with three double lamellæ within; peristome acute, the columellar margin slightly reflexed. *Z. polyodon*, Weinland and Martens. Hayti.

PROSERPINULA, Albers, 1860. Shell scarcely perforated, discoidal, hyaline, transparent; whorls 4½, planulate, the last slightly impressed at the base, with a shining callus around the perforation, spiral laminæ reaching the margin; peristome acute. *H. discoidea*, Ads. 2 sp. Jamaica.

HELICODISCUS, Morse. Minute, planorboid, with revolving striæ, aperture lamellarly toothed within the outer lip. *Z. lineatus*, Say (xciii, 9, 10). United States.

MICROPHYSA, Albers, 1860. (Microconus, Strebel and Pfeffer.) Shell umbilicated, depressed, thin, striulate, scarcely shining; spire flattened with distinct suture; whorls 4–5, slightly convex, slowly increasing, the last not deflected; aperture rounded-lunate; peristome thin, the margin converging. *Z. Boothianus*, Pfr. (xciv, 15). 37 sp. West Indies.

PELLA, Albers, 1860. Shell umbilicate or imperforate, orbicular depressed, thin, striate or striately plicate; whorls five, slightly convex; aperture lunately rounded; peristome simple, acute; columellar lip dilated, reflected, free. *H. bisculpta*, Benson (xciv, 16). So. Africa.

SAGDINELLA, Mörch, 1872. Not characterized. *H. Didrichsenii*, Mörch. Nicobar Is.

STRIATURA, Morse, 1864. Central plate of the radula enormous; buccal lamina almost smooth, with a median furrow and notch. *Z. milium*, Morse. United States.

JANULUS, Lowe, 1852. Shell umbilicated, depressed orbicular,

costulately strigate above, rather smooth below; whorls 7–8½, closely revolving, the last convex at the base; aperture lunar; peristome simple, thin, with a callous ring within. *H. stephanophora*, Desh. (xciv, 13). Madeira.

ACTINARIA, Pfeiffer, 1855. Not characterized. 4 sp. India. *H. Pirrieana*, Pfr.

PUNCTUM, Morse, 1864. Buccal plate composed of sixteen distinct oblong laminæ; the teeth of the radula are quadrangular plates with rather short denticles, similar to Carychium. Shell as in Hyalina. *H. minutissima*, Lea. United States.

MACROCYCLIS, Beck, 1837. Shell rather thin, widely umbilicated, depressed; the last whorl declining toward the aperture; aperture oval-rounded; peristome simple, sharp, the extremities approaching and the lower somewhat reflected. *Z. laxata*, Fer. (xciii, 93). Chili. 21 sp. California, Mexico, West Indies, Chili.

SELENITES, Fischer. Shell smaller, last whorl somewhat flattened above. Animal having the jaw of Zonites but the dentition of the Testacellidæ. North America. *Z. concavus*, Say (xciii, 94). Dr. Fischer has made this group the type of a family Selenitidæ, characterized by the peculiarities of jaw and dentition.

HAPLOTREMA, Ancey, 1881. Shell much smaller, peristome sharp. *Z. Duranti*, Newcomb.

MORCHIA, Albers, 1860. Shell widely umbilicated, depressed orbicular, rather thin, dark-colored, slightly striate, shining; whorls five; aperture semioval; peristome simple, acute; outer margin flexuous, columellar margin slightly thickened. *Z. concolor*, Fer. West Indies.

NANINA, Gray, 1834.

Distr.—503 sp. Universal, in tropical and subtropical regions of Asia, Africa and Oceanica.

Shell heliciform, perforated, dextral or sinistral, somewhat depressed, thin, polished, particularly inferiorly, rounded or carinated at the periphery; columellar lip short, reflected, often covering the umbilicus; outer lip simple or scarcely reflected.

Animal with two anterior mantle-lobes covering a part of the surface of the shell; foot long and narrow, posteriorly more or less truncated and glandular, the pore slit-like, sometimes surmounted by a horn-shaped protuberance. The mantle-lobes possess some power of lateral movement, and the faculty of expansion and retraction.

ARIOPHANTA, Desmoulins, 1833. Shell sinistral, umbilicated, thin, diaphanous, the last whorl sometimes angulated or carinated on the periphery. Animal similar to Helix, but having a very large tubercular caudal gland. *N. regalis*, Chemn. (xciii, 81).

Borneo. *N. lævipes*, Müll. (xciii, 86). Malabar. *N. Janus*, Chemn. (xciii, 87). Malacca.

OXYTES, Pfeiffer, 1855. Shell solid, obliquely striate or plicate, depressed, carinate, umbilicate; peristome expanded, thin, edentulous; columellar margin thickened. *N. oxytes*, Benson.

ROTULA, Albers, 1850. (Pachystyla, Mörch, 1852. Trochomorpha, Albers, partim.) Shell subperforated; spire depressed conical; last whorl carinated at the periphery; columella very short, vertical; lip simple. 19 sp. Mauritius, India, East Indies.

PACHYSTYLA, Mörch (restricted), 1852. *N. inversicolor*, Fer. (xciii, 89). Mauritius.

EREPTA, Albers, 1850. Shell with columellar tooth. *N. stylodon*, Pfr. (xciii, 90). Mauritius.

CÆLATURA, Martens. Shell spirally sculptured.

CALDWELLIA, H. Adams. Shell small, fragile, translucent, trochiform. *R. philyrina*, Morel.

RHYSOTA, Albers, 1850. Shell rugosely striated above, polished below; the last whorl depressed, dilated anteriorly, excavated around the umbilicus. *N. monozonalis*, Lam. (xciii, 85). Amboina.

TROCHONANINA, Mousson, 1869. (Martensia, Semper, 1870.) 12 sp. East Africa, East Indies, Polynesia. *N. Lychnia*, Gray (xciii, 88). Singapore.

ZINGIS, Martens. Shell heliciform, with a simple peristome; hinder extremity of the foot with mucous pore and a little prominence above it; jaw smooth, with median projection; marginal teeth of the radula bicuspidate. *N. radiolita*, Martens. Zanzibar.

EUPLECTA, Semper. Shell striated or ribbed above. Cervical lobes of the mantle developed, the left subdivided into two; shell-lobes rudimentary. 9 sp. Philippines. *N. Boholensis*, Pfr.

ORPIELLA, Gray, 1855. Shell thin, rounded, depressed, with four-and-a-half convex whorls, the last somewhat flattened basally. Animal with the anal lappet of Nanina covering the mucous pore, and six other smaller ones between this and the shell, arranged in a double series along the back of the tail. *N. scorpio*, Gould. Fiji Islands.

XESTA, Albers, 1850. (Xestina, Pfeiffer.) Shell perforate or narrowly umbilicate, orbicularly depressed, smooth, usually polished; aperture large, rounded ovate; margin acute; columellar margin dilated and reflexed. *N. citrina*, Linn. (xciii, 80). Moluccas.

BENSONIA, Pfeiffer, 1855. Not characterized. *N. splendens*, Hutton.

MACROCHLAMYS, Benson, 1832. (Tanychlamys, Benson, 1834.) Limited by Semper to the species of Nanina, the shells of which

are depressed globose, pellucid or corneous, smooth and shining both on the upper and under surface. Two long tongue-shaped shell-lobes; the left cervical lobe divided into two. *N. spectabilis*, Pfr.

EURYPUS, Semper, 1870. Foot with the back broad, not carinated. *N. casca*, Gould. Fiji Isles.

ROTULARIA, Mörch, 1872. Uncharacterized. *N. Reinhardi*, Mörch. Nicobar Isles.

GERONTIA, Hutton, 1883. Shell depressed, umbilicated, of about five gradually increasing whorls, aperture oblique, margin not reflected, thin. Animal heliciform; mantle rather posterior, included; tail acute, with a mucous pore, but no papilla. Jaw smooth, striated. *H. pantherina*, Hutton. New Zealand. Differs from Patula in having a mucous pore.

MEDYLA, Gray, 1855. (Otesia, H. and A. Adams, 1855.) Shell imperforate or scarcely rimate, depressed, thin; whorls few, rapidly increasing, the last rounded or carinate; aperture large, angulately lunar; lip simple, acute. *N. tecta*, Soul.

AMPHIDOXA, Albers, 1850. Shell perforated, depressed, thin, pellucid; whorls convex, rapidly increasing; aperture very oblique, large, oval; peristome simple, its extremities connected by a very thin callus. *N. marmorella*, Pfr. 2 sp. Juan Fernandez.

MICROCYSTIS, Beck, 1837. (Helicopsis, Beck, 1837. ? Platycloster, Hasselt.) Shell small, subperforated, glabrous; aperture large, subvertical. *N. Adamsi*, Pfr. (xciii, 83). Pitcairn's Isl.

MICROCYSTINA, Mörch. Shell polished, with a small notch at the pillar-lip. *N. Rinki*, Mörch. Nicobar Is.

SESSARA, Albers, 1860. Shell imperforate, depressly orbicular, costulate-striate above, angulate on the periphery; base smooth, excavated; aperture depressed, wide, toothed. *N. infrendens*, Gould. Distinguished from other Naninæ by the thickened columellar lip and toothed aperture; mantle-lobes small. Jaw smooth, finely radiate-striate on the inner side, with an obtuse middle projection.

THALASSIA, Albers, 1860. Shell imperforate or scarcely perforate, conic-orbicular, thin, pellucid; whorls five or six, slowly increasing, the last angulate or carinate, umbilical region impressed; peristome simple, acute; columellar margin slightly reflexed. *N. subrugata*, Pfr.

SOPHINA, Benson, 1859. Foot long, obliquely truncate at its posterior end, with a large gland and distinct horn-like appendage; mantle-lobes as large as in Helicarion. Shell with a callous columella, angulated at the basal margin, and with a more or less acute umbilical carina. *N. Calias*, Benson.

HEMIPLECTA, Albers, 1850. Shell granulose or striated above, polished below; last whorl more or less angular or carinated

at the periphery. *N. conoidalis*, Ad. and Reeve (xciii, 84). Philippines.

THAPSIA, Albers, 1860. Shell orbicularly depressed, thin, pellucid, undulately decussated, narrowly perforated; whorls six, slowly increasing; peristome simple, acute; columellar margin narrowly reflected. *N. troglodytes*, Morelet.

FAMILY HELICIDÆ.

Shell spiral, usually thicker than in the Zonitidæ, and mostly with reflected lip, the aperture edentulous or contracted by teeth.

Animal capable of complete retraction within the shell; the jaw finely striate, or ribbed, sulcate or plicate; teeth, central tricuspid, laterals bicuspid or tricuspid with an obsolete internal cusp, marginals usually wider than high, short, with two or three small cusps (xiii, 59).

HELIX, Linnaeus.

Distr.—3400 sp. Universal. Fossil; Cretaceous—. Europe; Laramie—. U. S.

Shell of variable form, smooth, rugose, striate, ribbed or tuberculate, sometimes pilose; orbicular convex, planorboid, trochiform, subturriculated, or short bulimiform (monstrosities sinistral, or with the whorls more or less uncoiled); aperture oblique, oval, or semilunar, with or without interior teeth on the margin or parietal wall; lip simple or thickened internally or reflected; umbilicus covered to widely open.

No precise diagnosis can be given of a genus in which the characters of the shell vary so much as in Helix. Albers, Beck, Swainson, Ferussac, H. and A. Adams, etc., have proposed a great number of groups, the species of which possess usually the double value of similar characters coinciding with similar distribution. Thus the species of a subgenus or section of Helix very generally strongly suggest by their facies and territory their descent from a common ancestry.

The number of species of Helix, although reduced by the elimination of the genera Nanina and Zonites, is still so large that a further separation would be very desirable; such groups as Patula, Sagda, etc., could be used in a generic sense with great advantage, provided conchologists would cease to apply to them the familiar designation Helix.

SAGDA, Beck, 1837. (Epistylia, Swainson, 1840.) Shell not umbilicated, globosely conoidal; spire more or less elevated, with obtuse apex; eight or nine whorls, the last flattened at the base, excavated around the umbilical region, with internal revolving lamellæ; columella short, oblique, dilated at the base; aperture obliquely semilunar; peristome simple. Jaw oxygnathous. 13 sp. Jamaica. *H. alligans*, Ads. (xciii, 2).

Hyalosagda, Albers, 1860. Shell scarcely perforated, depressed hyaline, thin; whorls 5–7, the last excavated at the base; aperture obliquely lunar; peristome acute, columellar margin scarcely dilated, slightly reflexed. *H. similis*, Adams. Jamaica.

PATULA, Held, 1837. (Eyryomphala, Beck, 1837. Delomphalus, Agassiz, 1837. Euryomphala, Herm., 1846. Discus [part], Ads., 1855.) Shell perspectively umbilicated, discoidal or turbinated, depressed, rugose or striated; whorls gradually enlarging; aperture rounded, unarmed by teeth; lip simple, sharp. Jaw smooth or slightly striated, with a more or less marked median projection. 327 sp. Universal.

Pyramidula, Fitz., 1833. *H. rupestris*, Drap. Europe.

Patulastra, Pfeiffer, 1878. Uncharacterized. *H. ampla*, Pfr. Mexico.

Discus, Fitz., 1833. *H. perspectiva*, Say. United States. *H. rotundata*, Müll. (xciii, 6). Europe.

Planogyra, Morse, 1864. Shell minute, perfectly flat above, umbilicus moderate; whorls very convex, the last one sharply ribbed. *H. asteriscus*, Morse (xciii, 7). United States.

Gonyodiscus, Fitz., 1833. *H. solaria*, Menke. Europe.

Acanthinula, Beck, 1846. (Zoogenites, Morse, 1864.) Shell perforated, globosely turbinated, with a brownish plicately ribbed or aculeate epidermis; whorls 4–5; aperture rounded; peristome thin, somewhat expanded, its extremities approaching. *H. harpa*, Say (xciii, 99). *H. aculeata*, Müll. (xciv, 40). 8 sp. United States, West Indies, Europe. Buccal plate transversely and longitudinally striate, its edge slightly indented with a middle projection. Viviparous, containing embryos in various stages of development at the same time.

Trichodiscus, Strebel and Pfeffer. Shell subdepressed, widely umbilicated, banded, beset with fine bristle-bearing warts; peristome shortly reflected. *H. coactiliata*, Fer. Mexico.

Thysanophora, Strebel and Pfeffer. Shell flat or conical, widely umbilicated, brown, with longitudinal plaits and rows of epidermal fringes; aperture simple. *H. impura*, Pfr. Mexico.

Lyra, Shuttlew. Shell with revolving lines. Canaries.

Patulopsis, Strebel and Pfeffer. Shell nearly flat, keeled, ribbed, with wide umbilicus. *H. carinata*, S. and P. Mexico.

Pseudohyalina, Morse, 1864. (Chanomphalus, Strebel and Pfeffer.) Distinguished from Patula by the minute size and more moderate umbilicus. *P. minuscula*, Say, etc. United States, Mexico, etc.

Anguispira, Morse, 1864. Shell large, depressed turbinate, banded or striped; umbilicus moderate. *P. alternata*, Say (xciii, 8). United States.

Stephanoda, Albers, 1860. Shell widely umbilicated, thin, depressed, plane above, convex below, with 5–7 close volutions,

at the periphery. *N. conoidalis*, Ad. and Reev
Philippines.

THAPSIA, Albers, 1860. Shell orbicularly de
lucid, undulately decussated, narrowly perf
slowly increasing; peristome simple, acute
narrowly reflected. *N. troglodytes*, More

FAMILY HELICI

Shell spiral, usually thicker than
with reflected lip, the aperture eder
Animal capable of complete r
jaw finely striate, or ribbed,
tricuspid, laterals bicuspid or
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No prec ... plane; aperture square depressed, lamellate; lip
characte ... *H. limonias*, Gray. 2 sp.
Swains ... *pa*, Albers, 1860. Shell thin, depressed, rarely conical.
great ... *licated*, with transverse ribs, sparsely bristly; whorls 4–5½
doub ... *last* not deflected in front; aperture slightly oblique, lunately
but ... *unded*; peristome simple, margins joined. *H. coma*, Gray
v ... *xciv*, 12); New Zealand. 48 sp.; Australasia.

Trochomorpha, Albers, 1850. (Geotrochus, Van Hasselt.) Shell umbilicated or subperforated, trochiform, the apex more or less obtuse; whorls somewhat flattened, the last with a carinated periphery; aperture depressed, oblique; peristome simple; columellar lip rarely thickened or dentate. 165 sp. India, East Indies, Polynesia.

Nigritella, Albers, 1860. Depressed trochiform, umbilicated, striate, shining, dark brown or blackish; whorls 7–8, the last plane or excavated beneath; aperture depressed, oblique, semi-oval or elliptical; peristome simple, thickened, outer margin flexuous, columellar margin callous. *H. nigritella*, Fer. *H. Pagodula*, Pfr. (xciii, 4 .

Albers, 1860. Narrowly umbilicate, trochiform, 7½, scarcely convex, base carinated, with rigid re angularly lunar; lip simple, acute; columellar expanded. *H. Guerini*, Pfr. 5 sp. India.
ford, 1863. Uncharacterized. *H. Barrak-* India.
A. Adams, 1852. (Discus, Albers, 1850.) ated, thin, discoidal, carinated at the hat elevated above, convex below; aper- ome simple, sharp or slightly thickened. n and Australasian. *H. acutimargo*,

ulema, Stoliczka.) Shell conoid, orls, usually spirally ribbed or y or indistinctly umbilicated; nded, outer margin simple. end of the foot, beneath a and two dorsal lobes on the l and with no separately produced thin, smooth, indistinctly concentrically middle. 7 sp. Southern Asia. *H. attegia*,

..YPTOSTOMA, Bland and Binney, 1873. Shell widely umbilicated, depressed, with wrinkle-like striæ, solid; whorls six, the last depressed globose, not reflected at the aperture; aperture oblique, subcircular; peristome simple, acute, thickened within, its extremities approaching; columellar lip scarcely reflected. Jaw imbricated; no mucous pore. The animal a true Helix, although the shell has some resemblance to the Zonitidæ. *Z. Newberryanus*, Binney (xciv, 14). California.

PHRIXGNATHUS, Hutton, 1883. Shell conical or turbinated, of five or six gradually increasing whorls; peristome thin, not reflected. Animal heliciform; mantle subcentral, reflected anteriorly over the shell; foot without locomotive disk, rounded posteriorly, without mucous gland. Jaw papillate, imbricately folded; teeth quadrate, the laterals bicuspid. *H. marginata*, Hutton. N. Zealand.

CARACOLUS, Montfort, 1810. (Discodoma, Swn., 1840, Serpentulus, Klein, Adams, 1855.) Shell solid, orbicularly depressed, carinated, flattened at base, umbilicated or imperforate; last whorl deflected at the aperture; aperture oblong, subangular, peristome thickened, reflected, widened below the columella, which extends to or covers the umbilicus. *H. caracolla*, Fer. (l, 16, scalariform). 16 sp. West Indies.

Polydontes, Montfort, 1810. Imperforate, globosely depressed, or conoidally globose, solid, striate; spire hardly elevated, conoidal, apex obtuse; whorls 5–5½, slightly convex; the last large,

and impressed sutures; last whorl narrow, not descending in front; aperture slightly oblique, rounded-lunate; peristome simple, acute, margins joined. *H. dissimilis*, Orb. South America.

Macrocycloides, Martens, 1867. Shell depressed, almost planorboid, shining, striate, hyaline, base slightly excavated, showing all the whorls; peristome acute, the margins slightly approaching. *H. obscurata*, Ad. and Reeve. 3 sp. East Indies.

Pitys, Beck, 1837. (Endodonta, Albers, 1850.) Shell small or minute, corneous, frequently with longitudinal brown bands, umbilicated or rarely subperforated; conical, orbicular, depressed or discoidal; aperture lunar, angular, very rarely rounded, with lamellar teeth upon the interior or parietal walls, or both; peristome simple, sharp. 56 sp. Polynesia. *H. lamellosa*, Fer. *H. contorta*, Fer. (xciv, 11). Sandwich Islands.

Libera, Garrett, 1881. Shell small, widely umbilicated, umbilicus (in adults) strongly constricted, so as to form a cavernous or pouch-like cavity; whorls 7–9, costulate or striate, last one angulate or carinate, rarely rounded; peristome simple; parietal region with one or two, and the palate with two or three internal laminæ; columella emarginate and furnished with a spiral fold. Polynesia. *H. fratercula*, Pease. Remarkable for their singular habit of ovipositing into their cavernous umbilicus—the constriction of which does not occur until the last two whorls are completed. Sometimes a temporary shelly plate retains the eggs or young within the umbilicus.

Laoma, Gray, 1849. Shell turreted, conical, scarcely perforated, smooth, pellucid, shining; whorls seven, flattened, the last carinated, base plane; aperture square depressed, lamellate; lip simple. *H. leimonias*, Gray. 2 sp.

Charopa, Albers, 1860. Shell thin, depressed, rarely conical, umbilicated, with transverse ribs, sparsely bristly; whorls 4–5½, the last not deflected in front; aperture slightly oblique, lunately rounded; peristome simple, margins joined. *H. coma*, Gray (xciv, 12); New Zealand. 48 sp.; Australasia.

Trochomorpha, Albers, 1850. (Geotrochus, Van Hasselt.) Shell umbilicated or subperforated, trochiform, the apex more or less obtuse; whorls somewhat flattened, the last with a carinated periphery; aperture depressed, oblique; peristome simple; columellar lip rarely thickened or dentate. 165 sp. India, East Indies, Polynesia.

Nigritella, Albers, 1860. Depressed trochiform, umbilicated, striate, shining, dark brown or blackish; whorls 7–8, the last plane or excavated beneath; aperture depressed, oblique, semi-oval or elliptical; peristome simple, thickened, outer margin flexuous, columellar margin callous. *H. nigritella*, Fer. *H. Pagodula*, Pfr. (xciii, 4).

Thysanota, Albers, 1860. Narrowly umbilicate, trochiform, thin; whorls 7½, scarcely convex, base carinated, with rigid hairs; aperture angularly lunar; lip simple, acute; columellar margin slightly expanded. *H. Guerini*, Pfr. 5 sp. India.

Kaliella, Blanford, 1863. Uncharacterized. *H. Barrakporensis*, Pfr. 3 sp India.

Videna, H. and A. Adams, 1852. (Discus, Albers, 1850.) Shell widely umbilicated, thin, discoidal, carinated at the periphery, flat or somewhat elevated above, convex below; aperture subtriangular; peristome simple, sharp or slightly thickened. 75 sp. Mostly Polynesian and Australasian. *H. acutimargo*, Pfr. Philippines (xciii, 5).

Sitala, A. Ad., 1856. (Conulema, Stoliczka.) Shell conoid, thin, consisting of many whorls, usually spirally ribbed or striated; base convex, narrowly or indistinctly umbilicated; margin of aperture thin, not expanded, outer margin simple. Animal narrow, long; gland at the end of the foot, beneath a distinct horn; two shell-lobes and two dorsal lobes on the mantle, all of them small and with no separately produced appendages; jaw thin, smooth, indistinctly concentrically striated in the middle. 7 sp. Southern Asia. *H. attegia*, Benson.

GLYPTOSTOMA, Bland and Binney, 1873. Shell widely umbilicated, depressed, with wrinkle-like striæ, solid; whorls six, the last depressed globose, not reflected at the aperture; aperture oblique, subcircular; peristome simple, acute, thickened within, its extremities approaching; columellar lip scarcely reflected. Jaw imbricated; no mucous pore. The animal a true Helix, although the shell has some resemblance to the Zonitidæ. *Z. Newberryanus*, Binney (xciv, 14). California.

PHRIXGNATHUS, Hutton, 1883. Shell conical or turbinated, of five or six gradually increasing whorls; peristome thin, not reflected. Animal heliciform; mantle subcentral, reflected anteriorly over the shell; foot without locomotive disk, rounded posteriorly, without mucous gland. Jaw papillate, imbricately folded; teeth quadrate, the laterals bicuspid. *H. marginata*, Hutton. N. Zealand.

CARACOLUS, Montfort, 1810. (Discodoma, Swn., 1840, Serpentulus, Klein, Adams, 1855.) Shell solid, orbicularly depressed, carinated, flattened at base, umbilicated or imperforate; last whorl deflected at the aperture; aperture oblong, subangular, peristome thickened, reflected, widened below the columella, which extends to or covers the umbilicus. *H. caracolla*, Fer. (i, 16, scalariform). 16 sp. West Indies.

Polydontes, Montfort, 1810. Imperforate, globosely depressed, or conoidally globose, solid, striate; spire hardly elevated, conoidal, apex obtuse; whorls 5–5½, slightly convex; the last large,

angulate, slightly descending in front; columella inclining, wide; aperture truncately ovate; peristome thickened, sometimes callously tuberculated, shortly reflected, patulous, basal margin callously dilated. *H. imperator*, Montf. (xcvi, 84). 5 sp. Cuba, Porto Rico.

Dentellaria, Schum., 1817. (Lucidula, Cyclodoma, Swn., 1840.) Shell imperforate, very rarely umbilicated, solid, depressed or conical globose; spire obtuse; last whorl deflected in front, mostly angular at the periphery; aperture oblique or subhorizontal, transverse; peristome thick, dentate or tuberculate within, its extremities joined by a heavy parietal callus. *H. Josephinæ*, Fer. (xcv, 72). 18 sp. West Indies, South America.

Pleurodonta, Fischer, 1807. (Caprinus, Montf., 1810. Lyrostoma, Mörch, 1852. Lucernella, Swn., 1840.) Shell orbicular, conoidal or lenticular, imperforate, or umbilicus covered; whorls five or six, flattened, the last carinated or angulated; aperture elliptical, oblique, nearly horizontal; peristome thick, subtrapezoidal, the extremities joined by a thickened callus, lower lip dilated, reflected, dentate within, with opposite exterior pits. *H. lucerna*, Müller. *H. soror*, Fer. (xcvi, 85). 35 sp. Jamaica.

Labyrinthus, Beck, 1837. (Lyrostoma, Swn., 1840.) Shell umbilicated, depressed orbicular, convex above and below; whorls five or six, the last carinated, depressed at the aperture; aperture nearly horizontal, auricular, grimacing, lamellated and dentate within; peristome thick, reflected, the extremities approaching, and continued subparallel into the umbilicus. *H. labyrinthus*, Chemn. (xcvi, 86). 22 sp. Central and South America.

Cepolis, Montfort, 1810. Shell umbilicated or partly covered, globosely depressed; whorls $4\frac{1}{2}$–5, the last suddenly deflected at the aperture, gibbous, scrobiculate or sulcate, tuberculate or plicately callous within; aperture elongate-lunate, peristome more or less expanded, the basal margin dilated, reflected, dentate or callous. *H. cepa*, Müll. 9 sp. Hayti, Porto Rico, Nicaragua, Java, China.

Isomeria, Albers, 1850. Shell umbilicated, depressed orbicular; last whorl obtusely angulated on the periphery, rounded in front, deviating near the aperture, ventricose at base, and contracted around the umbilicus; aperture oblique, semioval, with two interior teeth, one at the periphery, the other upon the opposite parietal wall; peristome thickened, reflected. *H. oreas*, Koch (xcvi, 87). 23 sp. Northern South America.

SOLAROPSIS, Beck, 1837. (Solarium, Spix, 1827. Ophiodermis, Agassiz, 1837.) Shell umbilicated, orbicularly depressed, flattened, conical above, convex below; last whorl obtusely carinated and peculiarly constricted at the periphery; aperture obliquely semilunar; peristome labiate, reflected; columellar lip

dilated. Jaw oxygnathous. *H. pellis-serpentis*, Chemn. (xcvi, 93). 26 sp. South America.

Psadara, Miller. Smaller and thinner, hairy, not keeled. 6 sp. So. America.

GONOSTOMA, Held, 1837. (Anchistoma, Kobelt, 1871.) Shell umbilicated, orbicularly depressed, with close volutions, often with fugacious hairs; whorls 5–7, slowly increasing, the last angulate or acutely carinate above; aperture oblique, narrowly lunar, often sinuate; peristome labiate, reflected, sometimes callous; parietal wall unarmed. Jaw odontognathous.

Drepanostoma, Porro, 1836. Shell discoidal, planorbiform, the last whorl nearly covering the previous ones, so that the axis is concave above and below; profoundly umbilicated; aperture subvertical; the outer lip reflected. *H. nautiliformis*, Porro (xciv, 19, 20). Italy.

Trigonostoma, Fitz., 1833. (Helicodonta, Risso, 1826. Vortex, Beck, 1837. Euphemia, Leach, 1846.) Typical group. *H. holosericea*, Studer (xciv, 21). 5 sp. Europe.

Caracolina, Ehr., 1831. (Caracollina, Beck, 1837.) *H. lenticula*, Fer. (xciv, 22). 25 sp. Mediterranean region, Madeira, etc.

Sculptaria, Pfeiffer, 1855. Uncharacterized. *H. sculpturata*, Gray. 2 sp. W. Africa.

Ophiogyra, Albers, 1850. Shell discoidal, many-whorled, plane above, concave below, showing all the whorls on either side; aperture very oblique, rounded; peristome slightly reflected, its extremities connected by a parietal callus.

Polygyratia, Gray, 1847. *H. polygyrata*, Born (xciv, 23). Brazil.

Systrophia, Pfeiffer, 1855. 15 sp. Central and South America. *H. helicycloides*, Orb.

CORILLA, Adams, 1855. (Atopa [part], Albers.) Often sinistral, widely umbilicated, discoidal, plane above, convex at base; last whorl compressed at the side, anteriorly deflected; peristome thickened, reflected, the margins joined by an elevated callus emitting a strong re-entering lamina. *H. Rivolii*, Desh. (xciv, 24). 8 sp. India, etc.

Stegodera, Martens, 1876. Shell like Corilla, but without parietal plica. *H. angusticollis*, Martens. China.

Plectopylis, Benson, 1860. Shell usually sinistral, subdiscoidal, widely umbilicated; parietal wall with a horizontal plica or ridge; several ridges within the aperture at irregular intervals, the first of them more or less remote. *H. leiophis*, Benson (xciv, 25). 24 sp. India, Burmah.

ÆGISTA, Albers, 1850. Shell widely and profoundly umbilicated; spire depressed conic; whorls slowly enlarging, the last well rounded; aperture small, oblique, subcircular; peristome

sublabiate, reflected, its extremities approaching. 6 sp. E. Asia. *H. oculus*, Pfr.

POLYGYRA, Say, 1817. Shell planorboid, many-whorled, whorls narrow, ribbed above, periphery angulate; aperture small, trigonal, with a V-shaped parietal tooth, joined by a raised callus to the extremities of the lip, but no lip-teeth; below plane, showing several whorls, with a narrow umbilicus; horn-color. *H. septemvolva*, Say (xciv, 26, 27). 22 sp. Southern United States, Mexico, West Indies, So. America.

Dædalochila, Beck, 1837. Shell small, depressed, ribbed-striate, periphery angulate, below convex, showing more than one, sometimes two whorls, with a minute central perforation; lip auricular, with internal teeth, marked externally by scrobiculations; parietal wall with a V-shaped tooth, callously joined to the extremities of the lip. *H. auriculata*, Say (xciv, 28, 29). 22 sp. Southern United States, Mexico, W. Indies, etc.

Polygyrella, Bland. (Adelodonta, Ancey.) Shell discoidal, ribbed above; two rows of three teeth within the last whorl; peristome thickened, simple, margins joined by a pliciform elevated triangular plate. *H. polygyrella*, Bland (xciv, 30, 31). Washington Terr., U. S.

Ammonitella, Cooper. Each whorl largely enclosed by its successor, so that the spire forms a crateriform depression; aperture vertically narrow; peristome obtuse, thickened; umbilicus large. *A. Yatesii*, Cooper (xciv, 32, 33). California.

STENOTREMA, Raf., 1819. (Stenostoma, Raf., 1831.) Shell small, often hirsute; aperture narrowly transverse, basal, extending from the periphery to the axis of the shell; parietal wall with a long lamellar tooth, lip broad, with generally a notch in the centre. Within the aperture, and near the axis, may be seen an accessory column or pillar, probably assisting the animal in retiring within its shell. *H. hirsuta*, Say (xciv, 34). 10 sp. United States, mostly east of the Rocky Mountains.

TRIODOPSIS, Raf., 1819. Shell globosely depressed, umbilicate; aperture trilobate, caused by denticles on the superior and inferior parts of the lip and on the parietal wall. *H. tridentata*, Say (xciv, 35). 8 sp. United States.

Xolotrema, Raf., 1819. Shell turbinate or depressed, frequently angulate or carinate on the periphery; base convex, imperforate; aperture trigonal; lip with a long lamellar tooth at the base, and frequently a small superior tooth; parietal wall with a large curved lamellar parietal tooth. *H. palliata*, Say (xciv, 36). 3 sp. United States.

Isognomostoma, Fitz., 1833. (Helicodonta, Moquin-Tandon, 1855.) Shell small, globosely depressed, umbilicus covered by the extremity of the lip; aperture tridentate, the two lip-teeth small, the parietal tooth larger, blade-shaped. Horn-color, fre-

quently hirsute. *H. personata*, Lam. (xciv, 37). 4 sp. United States, Europe.

MESODON, Raf., 1831. (Patera, Albers, 1850.) Shell umbilicated or imperforate, depressed globose, striate or costulate; last whorl deflected near the aperture; peristome reflected, white; parietal wall usually obliquely dentate. Shell usually corneous, without bands. *M. albolabris*, Say (xciv, 38). *H. multilineata*, Say, has revolving brown bands, which sometimes coalesce into a uniform brown. 20 sp. United States.

Ulostoma, Albers, 1850. Shell large, umbilicated, globosely depressed; aperture semicircular; lip reflected, tuberculately toothed at the base; sometimes with also a small parietal tooth. *H. profunda*, Say (xciv, 39). 2 sp. United States.

STROBILA, Morse, 1864. Shell minute, umbilicated, globosely conic or depressed, obliquely and coarsely striated, smoother below; whorls 5–6, the last globose; aperture lunately rounded, peristome thickened and reflected; the parietal wall and base of last whorl each with two or more revolving lamellæ. Animal with thick, bulbous tentacles, and large eyes. *H. labyrinthica*, Say (xciv, 18). 4 sp. United States, Mexico, West Indies.

THELIDOMUS, Swainson, 1840. Shell imperforate or very rarely umbilicated, solid, globosely depressed; spire short, obtuse; whorls four or five, the last contracted and deflected at the aperture, gibbous, obtusely angular on the periphery; aperture transversely oval; peristome very thick, reflected, the extremities connected by a wide callus, basal portion of lip often callously tuberculate or denticulate within. 21 sp. West Indies. *H.* (*Pachystoma*) *Guantanamensis*, Poey (xcvi, 77).

Leiocheila, Albers, 1850. (Leiostoma, Swainson, 1840.) Shell imperforate, subglobular, rather solid; spire short, obtuse, whorls three-and-a-half, the last very large, ventricose; aperture large, obliquely rounded; columella arcuated, widely callous; lip callously thickened. *H. Jamaicensis*, Chemn. (xcvi, 78). Jamaica.

Pachystoma, Albers, 1850. (Otala, Mörch, 1852.) Imperforate, very rarely narrowly umbilicate, solid, depressly globose; spire short, obtuse; whorls 4–5, the last protracted at the aperture, gibbous; sometimes obtusely angulated; peristome thick, the margins callously connected, base callous or denticulate. *H. auricoma*, Fer. Mostly Cuban.

Eurycratera, Beck, 1837. (Parthena, Albers, 1850, part.) Shell umbilicated or imperforate, rather thin, ventricose, obliquely oval; whorls few, very rapidly increasing, the last greatly developed; aperture oblong, oblique; peristome simple or slightly expanded below, the lips united by a thin callus; columellar lip narrowly reflected. *H. obliterata*, Fer. (xcvi, 81). 20 sp. Hayti.

Coryda, Albers, 1850. Shell imperforate, globosely conic or depressed; whorls five and a half, the last anteriorly deflected,

and excavated around the columella; aperture obliquely oval; peristome thickened within; columella much dilated and appressed. *H. alauda*, Fer. Cuba.

Histrio, Pfeiffer, 1854. Uncharacterized. *H. Dennisoni*, Pfr. Cuba.

Jeanneretia, Pfeiffer, 1877. Uncharacterized. *H. Parraiana*, d'Orb. 7 sp. Cuba, Porto Rico.

Dialeuca, Albers. Imperforate, turbinately globose; five whorls, the last obtusely angulate; aperture obliquely rounded; peristome simple, sharp; columella intrant, oblique, wide, flattened above. *H. nemoraloides*, C. B. Ad. (xcv, 65). Jamaica.

OXYCHONA, Mörch, 1852. Imperforated, trochiform; last whorl carinated with flattened base; peristome simple, sharp, outer lip inflected in the middle, columellar lip thickened. *H. bifasciata*, Burrow (xcv, 74). Brazil.

POLYMITA, Beck, 1837. (Phædra [pt.], Albers, 1850.) Shell imperforate or perforated, globular, shining; spire small and short: whorls four or five, the last very large and rounded; aperture rounded; peristome simple, obtuse, the extremities joined by a transparent callus; columella oblique, widely dilated above. *H. picta*, Born (xcvi, 80); Cuba. 5 sp. Cuba.

Cysticopsis, Mörch, 1852. (Parthena, Albers, 1850, *partim.*) Shell imperforate, globose, shining; whorls convex, the last ventricose; aperture large, rounded; columella short, vertical, a little dilated above; peristome simple. *H. Cubensis*, Pfeiffer. (xciv, 17). 20 sp. West Indies.

Praticola, Strebel and Pfeffer. Shell globular, irregularly plaited, aperture expanded, thickened internally, concealing a part of the narrow umbilicus. Mexico. *H. griseola*, Pfr., and *H. Berlandieriana*, Moric., are examples.

Pelia, Albers, 1860. Shell imperforate, depressed, lenticular, thin, with concentric lineated lines, acutely carinate; whorls five, slightly convex, the last with convex base, impressed in the middle; aperture subrhombic; peristome simple, acute. *H. spirulata*, Pfeiffer. Central America.

Plagioptychia, Pfr., 1855. Umbilicus narrow or covered, depressed suborbicular, thin, small, spire scarcely elevated, obtuse; whorls four-and-a-half, the last suddenly deflected and constricted at the aperture; aperture subhorizontal, elongate-lunate; peristome thin, margins approaching, the basal with a dentiform plica. *H. loxodon*, Pfr. (xcv, 70). 19 sp. Hayti, Bahamas, etc.

Hemitrochus, Swainson, 1840. (Phædra [pt.], Albers, 1850.) Shell imperforate or perforate, globose, shining, spire short, whorls 4–5, the last large, deflected at the aperture; aperture contracted, subvertical, rounded-lunate; peristome simple,

obtuse, margin callous, labiate within. *H. varians*, Menke (xcvi, 79). 21 sp. West Indies, Bahamas.

Leptoloma, Albers, 1860. (Dialeuca, Pfr., 1855.) Imperforated, depressly turbinate, base planulate; whorls five, the last obtusely angulate; aperture obliquely lunar; peristome acute, shortly expanded; columellar entering, dilated above, oblique. *H. fusco-cincta*, Ads. (xcv, 64). 11 sp. Jamaica, Cuba, Central America.

LEUCOCHROA, Beck, 1837. (Solarium, Schum., 1817. Calcarina, Moquin-Tandon, 1848. Iberus, H. and A. Adams [part], 1855.) Shell openly or narrowly umbilicated, globose or depressly globose, solid, cretaceous; whorls about five, the upper ones carinate, the last slightly descending in front; aperture lunately rounded; peristome simple, labiate or thickened within, margins joined by a thin callus; columella callously dilated, narrowing the umbilicus in the adult. *L. candidissima*, Drap. (xciii, 3). 17 sp. Mediterranean region.

HELICELLA, Fer., 1819. Shell generally umbilicated; peristome simple or labiate within, rarely dentate. Jaw odontognathous or aulacognathous. Distribution universal. *H. ericetorum*, Müll. (xcv, 48).

Hygromia, Risso, 1826. (Helicella, Fitz., 1833. Bradybæna, Beck, 1837.) Shell umbilicated or perforated, globosely depressed, corneous, sometimes hirsute; peristome sharp, labiate within, slightly reflected at the base. 200 sp. Universal; largely European. *H. hispida*, Müll. (xciv, 44).

Hispidella, Lowe, 1852. *H. nubigena*, Lowe. Canary Islands.

Ciliella, Mousson, 1872. *H. leprosa*, Shutt. 2 sp. Canary Islands.

Xerophila, Held, 1837. (Oxychilus, Fitz., 1833. Theba, Risso, 1826.) Shell perforated or umbilicated, turbinate or globosely depressed, rarely conic-orbicular, calcareous with corneous apex, shining; whorls five or six, gradually enlarging; aperture subcircular; peristome simple, labiate within. 200 sp. *H. ericetorum*, Müll.

Euparypha, Hartmann, 1840. Shell perforate, depressly globose, horny calcareous, filleted; whorls five, the upper ones flattened, carinate, the last inflated; aperture lunar, labiate within, columellar margin reflected. *H. Pisana*, Müll. (xciv, 46). Mostly European.

Heliomanes, Fer., 1819. Shell globose. Mediterranean region. *H. variabilis*, Drap.

Pseudoxerophila, Westerlund. Shell with fine spiral striæ and rows of punctiform impressions. *H. instabilis*, Ziegler, etc.

Monilearia, Mousson, 1872. 11 sp. Canary Islands. *H. phalerata*, Webb and Bertholet.

Lemniscia, Lowe, 1854. *H. Michaudi*, Desh. Porto Sancto.

Jacosta, Gray, 1821. (Crenea [pt.], Albers, 1850.) Shell

carinate. 28 sp. Mediterranean region. *H. filimargo*, Ziegler (xciv, 47).

Xeroleuca, Kobelt, 1877. Shell peculiarly sculptured; without markings. 4 sp. Northern Africa. *H. Mograbina*, Mor.

Helicopsis, Fitz., 1833. (Candidula, Kobelt, 1871.) 40 sp. Mostly Europe and Syria. *H. striata*, Drap.

Turricula, Beck, 1837. (Obelus, Hartmann, 1840. Crenea [pt.], Albers, 1850.) Shell conical, perforate or umbilicate, usually costulate, last whorl more or less angulated at the periphery. *H. pyramidata*, Drap. (xcvi, 49). 38 sp. S. Europe, N. Africa, Syria, etc.

Cochlicella, Risso, 1826. (Elisma, Leach, 1840. Longæva, Muhlf.) Shell narrowly perforate, turreted-conical, white, fasciate; whorls 6–9, the last usually subangulate; aperture rounded-oval; peristome simple, acute, the margins approaching. *H. acuta*, Müll. 9 sp. Southern Europe, etc.

OCHTHEPHILA, Beck, 1837. Shell umbilicated or perforated, trochiform or subdiscoidal, striate, ribbed or granulate; whorls 4–8, the last carinated or angulated, deflected near the aperture; aperture circular or subcircular; peristome continuous, the extremities joined by a ridged callus, more or less thickened, a little reflected. 28 sp. Canary Islands, Madeira.

Hystricella, Lowe, 1854. Shell conuloid or trochiform. *H. bicarinata*, Lowe (xcv, 50). Madeira.

Geomitra, Swains., 1840. (Coronaria, Lowe, 1854.) Shell mammillate. *H. coronata*, Desh.

Heterostoma, Hartmann, 1844. (Spirorbula, Lowe, 1854.) Shell planorbiform. *H. paupercula*, Lowe.

Irus, Lowe, 1854. (Placentula, Pfr., 1855.) Shell turbinately depressed. *H. depauperata*, Lowe.

Placentula, Lowe, 1854. Shell discoidally depressed. *H. Maderensis*, Wood.

Actinella, Lowe, 1854. (Rimula, Lowe, 1854. Caseolus, Lowe, 1854.) Shell narrowly umbilicated or subperforated, globosely depressed; the last whorl more or less carinated or angulated, slightly deflected in front; aperture oblique; peristome simple, plaited within; lip reflected at the base, its extremities more or less approaching and connected by a callus. 18 sp. Madeira. *H. compacta*, Lowe.

Tectula, Lowe, 1854. Shell umbilicate or narrowly perforate, depressed pyramidal, scabrously granulate; last whorl carinate; peristome simple, callously labiate within, the approximating margins joined by a thin callus. *H. Bulweri*, Wood. 3 sp. Madeira.

Craspedaria, Lowe, 1854. Shell with revolving ribs. *H. delphinula*, Lowe. 2 sp. Madeira.

Discula, Lowe, 1854. Shell like Tectula, but depressed. *H. polymorpha*, Lowe. 20 sp. Madeira.

Callina, Lowe, 1854. *H. rotula*, Lowe. Porto Sancto.

PLECTOTROPIS, Albers, 1860. (Thea, Albers, 1850.) Shell openly and profoundly umbilicate; lenticular, thin, diaphanous, carinate; whorls six-and-a-half, slowly increasing, the last not descending; carina acute, compressed, crenulate; aperture securiform or subrhomboidal; upper margin of peristome thin, somewhat expanded, basal margin scarcely dilated, shortly reflected. 38 sp. Eastern Asia, Australia. *H. elegantissima*, Pfr. (xcv, 51).

VALLONIA, Risso, 1826. (Circinaria, Beck, 1837. Lucena, Moquin-Tandon, 1855. Corneola, Held, 1837. Chilostoma, Fitz., 1833. Glaphyra, Albers, 1850. Amplexus, Brown, 1827. Zurama, Leach, 1820.) Shell somewhat depressed, diaphanous, umbilicated; whorls three or four, rounded; aperture oblique, subcircular; peristome with white reflected lip, its extremities joined by a parietal callus. Species all minute. *H. pulchella*, Müller (xciv, 41, 42), inhabits the northern regions of both hemispheres, and is a common shell throughout the northern United States and British America; unlike the essentially American forms it seems to prefer open gardens to damp woodlands, thus betraying its European origin. *H. pulchella*, Müll. 4 sp. Europe, United States, Australia.

PETASIA, Beck, 1837. (Trochiscus, Held, 1837. Perforatella, Schlüter, 1838. Dibothrion, Pfr., 1855.) Shell thin, narrowly perforated, turbinately globose, closely wound; whorls 6–8, the last not deflected; aperture obliquely lunate; peristome labiate within, patulous or subreflected, basal margin dentate. *H. bidens*, Chemn. (xciv, 43). 2 sp. Europe, Siberia.

FRUTICICOLA, Held, 1837. (Helicella, Stabile, 1864.) Shell umbilicate or perforate, depressly globose, sometimes hairy; whorls 5–6, somewhat convex; aperture widely lunar or lunately rounded; peristome acute, slightly expanded, labiate within, basal margin reflected. *H. fruticum*, Müll.

Monacha, Hartmann, 1840. Shell conical, perforate; peristome labiate and reflected. *H. incarnata*, Müll.

Nummulina, Kobelt, 1871. *H. nummus*, Ehrenberg (xciv, 45). 5 sp. Syria, etc.

Carthusiana, Kobelt, 1871. (Teba, Strobel, 1850. Theba, Stabile, 1864.) *H. carthusiana*, Müll. European.

Zenobia, Gray, 1821. Shell conoidal, perforate, peristome simple. *H. cinctella*, Drap. European.

Trichia, Hartmann, 1840. (Petasina, Mörch, 1852.) Shell depressed, closely whorled, usually pilose; columellar margin callous. *H. villosa*, Drap. Mostly European.

CAMÆNA, Albers, 1850. Umbilicated, sinistral, turbinated

or globosely depressed; whorls 4–7, the last anteriorly deflected, somewhat angular usually, convex at base, compressed around the umbilicus; aperture elliptical-rounded; peristome more or less thickened, reflected, its extremities approaching. *H. cicatricosa*, Müll. (xcvi, 95). 7 sp. China, Japan.

ACUSTA, Albers, 1860. Shell umbilicate, thin, globose, closely striated, shining; last whorl large, rounded; spire subconical, aperture scarcely oblique, lunately rounded; peristome simple, acute; columellar margin dilated, reflected. 11 sp. China, Japan. *H. ravida*, Benson.

SATSUMA, Adams, 1868. Shell globosely conoidal, perforate; lip reflected, the lower portion and base of shell plane. *H. Largillierti*, Phil. 6 sp. Japan.

TRACHIA, Albers, 1860. Shell umbilicate, depressed, thin, roughened by minute granules; spire scarcely elevated; whorls four, somewhat flattened, the last deflected at the aperture and constricted in front; aperture obliquely subcircular; peristome thin, expanded, margins approximating, joined by a thin callus. *H. asperella*, Pfr. 22 sp. India, East Indies.

ANGASELLA, Adams, 1863. *H. cyrtopleura*, Pfeiffer. 3 sp. Australia.

EURYSTOMA, Albers, 1850. Shell narrowly umbilicated, globosely depressed, calcareous; whorls five, the last convex at base, deflected near the aperture; aperture oval, contracted by the last whorl; peristome lipped, wide, its extremities approaching and joined by a callus; columellar lip straight within, dilated, nearly touching the umbilicus. *H. vittata*, Müll. (xcv, 58). Ceylon.

PHASIS, Albers, 1850. Shell umbilicated, thin, depressed, convex at the base, spire a little elevated; whorls four, rapidly increasing; aperture vertical, oval; peristome simple, sharp; columellar lip dilated, reflected. *H. Menkeana*, Pfr. Cape of Good Hope.

COCHLEA, H. and A. Adams, 1855. Shell more or less globular, solid, colored; usually banded; peristome thickened or reflected; aperture rarely dentate. *H. aspersa*, Müll.

Odontura, Crosse and Fischer. Shell narrowly umbilicate, depressed globular, granulate or hairy; peristome reflected. Jaw with numerous longitudinal ribs and close transverse striæ; hinder part of foot with a median serrated keel. *H. Ghiesbreghti*, Nyst. (xcv, 52). Mexico.

Lysinoë, H. and A. Adams, 1855. (Aglaja, Albers, 1860.) Shell umbilicate, orbicularly convex, banded; whorls 4½–6, the last deeply deflected in front; aperture broad-lunate, oblique; peristome thickened, expansively reflected, white, the margins approaching; that of the columella partially covering the umbilicus. *H. fidelis*, Gray (xcv, 53). 36 sp. Oregon to Peru.

Epiphragmophora, Strobel. Shell umbilicate, fusco-calcareous, peristome expanded, nearly circular; a solid calcareous epiphragm. Jaw four-ribbed, crenate. 2 sp. Argentine Republic. *H. Cuyana*, Strobel.

Eurycampta, Albers, 1860. Shell perforate, orbicularly convex; obliquely rugose-striate; brownish red, often banded; whorls 4½–5, the last descending; aperture ovate; peristome white, expanded-reflected, margins approaching. *H. Bonplandi*, Lam. 7 sp. Cuba, Argentine Republic.

Leptarionta, Crosse and Fischer. Intermediate between Arionta and Fruticicola; shell colored as in the former, but thin and translucent as in the latter. *H. bicincta*, Pfr. Mexico.

Micrarionta, Ancey. Shell smaller, subangulate at the periphery; lip thicker, its extremities approaching, and callously connected, impinging on the umbilicus. *H. facta*, Newcomb. Sta. Barbara Isl., Cal.

Arionta, Leach, 1820. Shell perforated, turbinately globose, thin; whorls six, convex; peristome lipped; columellar lip dilated near the umbilicus. *H. arbustorum*, Linn. (xcv, 56). Europe. *H. Californiensis*, Lea (xcv, 57). California. Different as are the habitats of these two groups of species, the shells are sufficiently related to justify placing them together in a subgenus. Curiously, they are geographically separated by the whole United States east of the Rocky Mountains, which does not contain a single species referable here.

Campylæa, Beck, 1837. (Helicigona, Risso, 1826. Corneola, Moquin-Tandon, 1855. Cingulifera, Held, 1837.) Shell umbilicated, planospiral, orbicularly depressed, more or less solid, glabrous or hirsute; 4½–6 whorls, the last deflected near the aperture; aperture oval or subcircular; peristome lipped, more or less thickened, its extremities approaching and joined by a callus; columellar lip dilated, reflected at the base, very rarely touching the umbilicus. 100 sp. Mostly Mediterranean region.

Xerocampylæa, Kobelt, 1871. *H. Carascalensis*, Fer.

Fruticocampylæa, Kobelt, 1871. *H. Ravergiensis*, Fer.

Eucampylæa, Pfeiffer, 1878. (Cingulifera, Held, 1837. Corneola, Held, 1837. Chilostoma, Moquin-Tandon, 1855.) Typical group. *H. Pouzolzi*, Payr. (xcv, 54).

Tacheocampylæa, Pfeiffer, 1877. *H. Raspailii*, Payr.

Elona, Adams, 1855. (Sterna, Albers, 1850.) Shell planorboid, flattened above, spire involute, apex immersed; peristome labiate within. *H. Quimperiana*, Fer.

Chilotrema, Leach, 1820. (Latomus, Fitz., 1833. Lenticula, Held, 1837. Vortex, Moquin-Tandon, 1855.) Shell umbilicated, lenticular, strongly carinated; five whorls, the last deflected near the aperture; aperture basal, horizontal, oval; the reflected lip continuous, angular. *C. lapicida*, Linn. (xcv, 55). Europe.

Eremina, Pfr., 1855. (Erinna, Mörch, 1865. Eremophila, Kobelt, 1871.) Shell depressed globose, sharply striate, cretaceous, base convex. *H. desertorum*, Försk. (xcv, 59). 5 sp. Egypt.

Tachea, Leach, 1820. (Archelix, Albers, 1850. Cepæa, Held, 1837.) Shell imperforate, or umbilicus covered, turbinately globose or depressed; last whorl ventricose, deflected at the aperture, other whorls somewhat flattened; aperture obliquely rounded; peristome reflected; columellar lip narrow, callous, gibbous. 11 sp. Europe. *H. hortensis*, Müll. (xcv, 61), the common garden-snail of Europe, is a representative of this group, which includes several species. Introduced into the United States, it has become acclimated at several localities.

Rhagada, Albers, 1860. Shell imperforate, subglobose, striate, white, fasciate; whorls regularly increasing, slightly convex, the last slightly deflected in front, base convex; aperture obliquely lunar; peristome a little expanded, labiate within. *H. Reinga*, Gray (xcv, 60). 6 sp. Australia, New Zealand.

Pomatia, Beck, 1837. (Cœnatoria, Held, 1837.) Shell globose, striate, corneo-calcareous, umbilicus partly covered or imperforate, usually fasciate; whorls 4–6, convex, the last large, ventricose, descending in front; aperture lunately orbicular, peristome patulous or straight, callous within, columellar margin reflected, usually callous. *H. pomatia*, Linn. (xcvi, 76). 45 sp. Mostly Europe, Western Asia and Northern Africa. Throughout Southern Europe the breeding of the edible snail (*Helix pomatia*) is very extensively carried on; it has been stated that Marseilles ships annually to Paris and London from 500 to 750 tons of this mollusk, and Genoa exports an equal quantity. Foreign residents in the United States are believed to be large consumers of this delicacy. In the markets of the warmer regions of Europe basketfuls of live snails are among the most familiar articles of food exposed for sale.

Cantareus, Risso, 1826. (Lucena, Hartmann, 1821. Tapada, Gray, 1840.) Paucispiral, thin, diaphanous, imperforate, peristome simple, sharp. *H. aspersa*, Born.

Cryptomphalus, Moquin-Tandon, 1855. Rather thin, imperforate; with thin, twisted columella; epiphragm plane, membranaceous. *H. aspersa*, Müller (i, 17, scalariform). 13 sp. Europe, Australia, Mexico.

Macularia, Albers, 1850. (Otala, Moquin-Tandon, 1855.) Imperforate, turbinate or globosely depressed; whorls four or five, convex, the last deflected near the aperture; aperture obliquely rounded; peristome sharp, lipped; columellar lip dilated, appressed, covering the umbilicus. *H. Niciensis*, Fer. (xcv, 62). 44 sp. Mediterranean region.

Iberus, Montfort, 1810. Shell narrowly umbilicated, depressed

orbicular, more or less rugose, white, obsoletely banded; whorls 4–5, the last descending in front; aperture obliquely oblong; peristome simple, expanded, labiate within; columellar margin reflected. *H. Gualtieriana*, Linn. (xcv, 63). 50 sp. Mediterranean region.

Murella, Pfr., 1877. Shell not carinated at the periphery. *H. muralis*, Müll.

Levantina, Kobelt, 1871. *H. guttata*, Oliv. 11 sp. Western Asia.

Iberus (typical). Shell carinate at the periphery. *H. Gualtieriana*, Linn.

Hemicycla, Swainson, 1840. (Mycena, Albers, 1850.) Shell imperforate, globosely depressed, rugose; four or five whorls, the last gibbous, deflected in front; aperture obliquely oval; peristome thickened, its superior and inferior lips subparallel or approaching and usually connected by a columellar callus, the inferior one lamellate within. 37 sp. Canary and Cape Verd Is. *H. Saulcyi*, d'Orb (xcv, 66).

Plebecula Lowe, 1854. (Helicomela, Lowe, 1854.) Shell umbilicated or narrowly perforate, subglobose, striated, hispidly granulate; whorls 5–5½, convex, the last but little deflected anteriorly; aperture rounded; peristome simple, diffusely callous within; margins approaching, that of the columella dilately reflexed. *H. punctulata*, Sowb. (xcv, 67). 5 sp. Madeira.

Leptaxis, Lowe, 1852. (Katostoma and Cryptaxis, Lowe, 1864.) Shell thin, globose or depressly globose, striated or rugose; whorls 5–5½, the last descending, with convex base; columella straight, entering, more or less dilated below, aperture large, rounded-lunar, or subrhombic; peristome simple, lipped within, margins approaching. *H. undata*, Lowe (xcv, 68). 30 sp. Madeira,

Leptaxis (restricted). Not carinate, imperforate.

Pseudocampylæa, Pfeiffer, 1877. Shell perforate, subcarinate. *H. Lowei*, Fer.

Lampadia, Albers, 1854. (Mitra, Albers, 1850.) Periphery carinate, depressed. *H. Webbiana*, Lowe (xcv, 69). Madeira.

DORCASIA, Gray. (Galaxias, Beck, 1837.) Shell umbilicate, subglobose; whorls convex, the last ventricose, descending at the aperture; aperture generally shining within; peristome thick, expanded, reflexed, rarely simple, obtuse, margins approximating, often joined by a callus, the columella dilated, reflexed, somewhat covering the umbilicus. *H. argillacea*, Fer. (xcvi, 94). 37 sp. So. Africa, East Indies, Australia.

HADRA, Albers, 1860. (Papuina, Albers, 1860.) 119 sp. E. Indies, China, Japan, Australia. *H. bipartita*, Fer.

XANTHOMELON, Albers, 1850. Shell striulate, globose, with a yellowish epidermis; spire small, obtusely conoidal; whorls 4–5,

the last large, inflated, descending; aperture semioval; lip thickened, shortly reflected, white, margins joined by a thin callus; columellar lip strict, callous, subtuberculate. *H. pomum*, Pfr. (xcvi, 96). 9 sp. Australia.

Anoglypta, Martens, 1860. *H. Launcestonensis*, Reeve. Tasmania.

THERSITES, Pfeiffer, 1855. Imperforate, trochiform, solid; spire conical, apex obtuse; whorls five-and-a-half, flat, the last carinated, with flattened base; aperture obliquely subrhombic, sinuously rostrate in front; peristome somewhat thickened, shortly expanded, the margins callously joined. *H. Richmondiana*, Pfr. Australia.

MEROPE, Albers, 1850. Shell imperforate, depressly globose, slightly striate, fasciate, spire very obtuse; whorls four-and-a-half, convex, the last subangulate at the periphery, umbilical region impressed, slightly deflected at the aperture, constricted, gibbous; aperture irregular, sinuately triangular; peristome filiformly callous, slightly expanded, columellar margin straight, tuberculate in the middle. *H. fringilla*, Pfr. 3 sp. Australasia.

CHLORITIS, Beck, 1837. (Erigone, Albers, 1850. Semicornu, Klein, Ads., 1855.) Shell rather solid, somewhat planorbiform, globosely depressed, profoundly umbilicated, concave above and below; spire enveloping; last whorl large, subcylindrical, anteriorly much deflected; aperture obliquely semioval; peristome a little thickened, shortly reflected, its extremities approaching. *H. ungulina*, Linn. (xcvi, 91). 32 sp. East Indies.

PEDINOGYRA, Albers, 1860. Shell widely umbilicated, depressed, solid, spire flattened, obtuse; whorls 5–6, the last large, deflected anteriorly, dilately protracted; aperture nearly horizontal, elongate-lunate; peristome expanded, margins approaching, the basal margin reflected. *H. Cunninghami*, Gray. 3 sp. Australia, New Guinea.

AMPELITA, Beck, 1837. Shell widely umbilicated, rather thin, depressed; whorls four or five, the last oblique above, deflected at the aperture; aperture oblique, oval; peristome reflected. *H. sepulcralis*, Fer. (xcvi, 92). 30 sp. Madagascar, Southern Africa.

OBBA, Beck, 1837. Shell umbilicate, ovate-globose or orbicularly depressed, frequently angulate, apex very obtuse; whorls $4\frac{1}{2}$–6, the last deflected in front; aperture oblique or horizontal, oblong-ovate or elliptical; peristome thickened or reflected, joined by a callous margin; basal margin dilated, usually tuberculate within, impinging on the umbilicus. *H. mamilla*, Fer. (xcvi, 89). 40 sp. East Indies, Philippines.

Janira, Albers, 1850. Shell umbilicated, conoidal, subglobose, with obtuse apex; last whorl descending in front; aperture obliquely subrotund; peristome thickened, reflected,

the lips united by a shining callus; columellar lip with a tooth. *H. Ceres*, Pfr.

Phania, Albers, 1860. Shell umbilicated or imperforate, lenticularly depressed, acutely carinate; whorls $4\frac{1}{2}$–5, the last shortly descending anteriorly, base convex; aperture irregularly triangular or rhomboidal; peristome thickened, expanded; columellar margin tuberculately dilated, the base reflected, appressed. *H. pyrostoma*, Fer. (xcvi, 88). 7 sp. East Indies.

Planispira, Beck, 1837. (Pusiodon [part], Swainson, 1840.) Shell with open (rarely covered) umbilicus, orbicularly depressed; spire plane or immersed in the middle; whorls 4–5, the last large, declining in front; aperture obliquely oblong-ovate; peristome acute, widely expanded, reflected, margins approximating, the basal margin sometimes tuberculate. *H. coluber*, Beck (xcvi, 90). 26 sp. East Indies.

Philina, Albers, 1850. (Pusiodon, Swains., 1840. Obbina, Semper, 1873.) Shell umbilicate, orbicularly depressed, apex very obtuse; last whorl deflected in front; aperture oblique or horizontal; peristome thickened, reflected, the margins joined by a callus, which impinges on the umbilicus. *H. planulata*, Lam.

GEOTROCHUS, Beck, 1837. Shell imperforate or perforation covered, trochiform, with elevated spire and flattened whorls; last whorl carinated or angular, base subplane; aperture angular, very oblique; superior lip slightly reflected or expanded, inferior lip thicker and reflected. *H. Ferussaci*, Lesson (xcv, 73). 131 sp. Solomon and Louisiade Is., New Guinea, Australia.

Pseudopartula, Pfr., 1855. *H. galericulum*, Mouss. Java.

ACAVUS, Montfort, 1816. (Otala, Schum., 1817.) Shell imperforate, globose-turbinate, oblique; whorls 3–4, rapidly increasing, the last ventricose; aperture oblong, oblique; columella oblique, wide, covered by an excavated callus; peristome thick, widely reflected, the extremities united by a shining callus. *H. hæmastoma*, Linn. (xcv, 75). 8 sp. Ceylon.

ALBERSIA, H. Adams, 1865. *H. granulata*, Quoy. 3 sp. New Guinea.

HELICOPHANTA, Beck, 1837. (Liostoma, Swains., 1840. Eurycratera, Ads., 1855.) Shell with open or covered umbilicus; thin, ovately oblong, spire short, scarcely elevated; whorls $3\frac{1}{2}$–4, very rapidly increasing, the last inflated; aperture large, obliquely oblong-ovate; lip subexpanded, slightly thickened, margins joined by a usually thin callus, columellar margin dilated, reflected. *H. magnifica*, Fer. (xcvi, 82). 9 sp. Madagascar.

PANDA, Albers, 1860. (Eurycratera, Ads., 1855, part.) Shell globosely ovate, thin, striate, granulately decussated by spiral lines; spire obtuse, whorls 3–4, rapidly increasing, the last large, swollen; aperture scarcely oblique, rounded-ovate; peristome

simple, the margins joined by a thin callus, the columellar margin dilated, reflected. *H. Falconari*, Reeve. 5 sp. Australia, Madagascar, India.

STYLODONTA, Crist. et Jan., 1837. (Columplica, Mousson, 1844.) Shell imperforated, conoidal above, globose below; whorls six or seven, the last ventricose; aperture somewhat narrow, oblique; columella short, nearly direct, dentate and truncate; peristome thin, reflected at the base, extremities united by a very thin parietal callus. *H. cepoides*, Lea (xcvi, 83). 4 sp. Seychelles and Philippines.

EREPTA, Albers, 1850. Shell imperforate, rather depressed, solid, the last whorl subangulated; columella short, oblique, truncate, with a strong tooth; peristome simple, the basal margin somewhat thickened. *H. Stylodon*, Pfr. (xcv, 71). 13 sp. Mauritius.

COCHLOSTYLUS, Fer., 1819. (Bulina, Lesson, 1831. Helicostyla, Mörch, 1865. Cochlostyla, Issel, 1874.) Shell not umbilicated, oval, conical, subbulimiform, ventricose; apex somewhat obtuse; aperture large, ovate; columella straight, sometimes slightly arcuated; peristome wide, reflected. 214 sp. Philippines, etc.

Axina, Albers, 1850. Shell imperforated, usually covered by a transparent, caducous epidermis, depressed or subtrochiform; whorls four or five, flattened, the last carinate on the periphery; aperture securiform; columella short, callous, oblique; peristome labiate, reflected at the base. *H. siquijorensis*, Brod. (xcvi, 97). 10 sp. Philippines.

Pfeifferia, Gray, 1853. (Named after Dr. Louis Pfeiffer, author of Monographia Heliceorum Viventium, etc.) Shell globular, imperforate, thin, fragile, white, pellucid; spire not prominent, the last two whorls very large, forming nearly the entire shell; aperture rounded; lip thin, sharp. Animal too large for complete retraction within the shell; mantle-margins reflected upon a part of the surface of the shell and forming a border on the peristome; foot moderate, depressed and attenuated posteriorly, and without muciparous gland. *H. micans* (xcii, 75, 76) occurs on the leaves of bushes in the Island of Luzon. 2 sp. Philippines.

Chloræa, Albers, 1850. (Thersites, Mörch, 1865.) Shell shining, imperforate, flattened, globosely depressed or lenticular; whorls four or five, the last angular or carinated; aperture oblique, nearly horizontal, elliptical; peristome sharp, the extremities approaching, the basal lip widened, reflected. *H. fibula*, Brod. 10 sp. Philippines.

Corasia, Albers, 1850. Shell imperforate, depressed, rarely orbicularly conic, thin, diaphanous, flattened above, rounded below; whorls 4–6, the last very often angulated or carinated; aperture oblique, angular, large; columella intrant, thin,

oblique, forming an angle with the basal lip; peristome simple, thin, slightly labiate, rarely sharp. *H. virgo*, Brod. (xcvi, 98). 36 sp. Philippines. Solomon's Isles.

Calocochlea, Hartmann, 1840. (Callicochlias [Hartmann], Agassiz, 1847.) Shell generally covered with a deciduous, hydrophanous epidermis, imperforate, very rarely umbilicated, globosely depressed; whorls rather flat towards the apex, the last inflated; columella often intrant, dilated, oblique; peristome widely expanded, thickened, shortly reflexed. *H. pulcherrima*, Sowb. (xcvi, 99). 37 sp. Philippines.

Helicobulinus, Brod., 1840. (Chromocochlea, Hartm., 1844.) Shell turbinate-globose, the last whorl ventricose and forming a great part of the shell; apex obtuse; aperture rounded; columella straight; peristome widely reflected. *H. sarcinosa*, Fer. (xcvii, 100). 5 sp. Philippines.

Helicostyla, Fer., 1819. (Orustia, Mörch, 1852.) Shell imperforate, globosely conical, often covered with a deciduous, hydrophanous epidermis; spire elevated, apex very obtuse, whorls 4–8; columella solid, arcuately ascending from the broad callous base; aperture ovately lunar, nearly longitudinal, margins equal; peristome expanded, or rarely shortly reflected. *H. annulata*, Sowb. (xcvii, 3). 34 sp. Philippines.

Cochlodryas, Martens, 1860. Shell imperforate, turbinate or oblong-ovate, smooth, highly colored; spire short, obtuse; whorls 4½–5½, convex; columella dilated, nearly direct; aperture lunar-ovate; peristome simple or somewhat thickened, expanded or shortly reflected. *H. polychroa*, Sowb. 14 sp. Philippines.

Eudoxus, Albers, 1850. Shell imperforate, oval-oblong, or elongated-conical; whorls six or seven, flattened, the last usually somewhat angulated; columella straight, elongated, twisted or dentate; peristome simple, rarely thick. *H. effusa*, Pfr. 9 sp. Philippines.

Orthostylus, Beck, 1837. (Pythohelix, Swains., 1840. Hypselostyla, Martens, 1867.) Shell imperforate, ovate-conical or oblong-pyramidal, fuscous under a hydrophanous epidermis; spire conoidal, apex obtuse; whorls 5–7, slightly convex; columella subvertical, rarely slightly arcuate; aperture ovately rounded; peristome somewhat thickened, shortly expanded or reflected, interior usually colored. *H. fulgetrum*, Brod. (xcvii, 1). 43 sp. Philippines.

Phengus, Albers, 1850. Shell thin, hyaline, imperforated, pyramidal; whorls six, the last somewhat angulated; aperture subovate; columella arcuated; peristome sublabiated; columellar lip dilated, excavated. *H. evanescens*, Brod. (xcvii, 2). 12 sp. Philippines, India.

Phœnicobius, Mörch, 1852. Shell rimate, ovate, obliquely striate or costulate, chestnut-brown, indistinctly fasciate; whorls

6–7, tumid, slowly increasing, the last rather small; aperture semioval, oblique; columella short, callous or distinctly dentate; peristome expanded, the margins subapproximating and joined by a very thin callus, base frequently unidentate. *H. arata*, Sowb. (xcvii, 4). 7 sp. Philippines, Formosa.

Chrysallis, Albers, 1850. Shell perforate, conically ovate; whorls 5–7, hardly convex; spire cylindrically conical, apex obtuse; columella strict, wide, subreceding; aperture oblong-ovate; peristome simple, widely expanded; columellar margin dilated and reflected. *H. chrysalidiformis*, Sowb. (xcvii, 5). 4 sp. Philippines.

Canistrum, Klein, Mörch, 1852. Shell subperforated or imperforate, sometimes sinistral, oval-oblong or subfusiform; whorls 6–7; columella straight, dilated, rarely arcuated; aperture oblong, angular above; peristome thick, more or less widely reflected, very rarely thin. *H. Luzonica*, Sowb. (xcvii, 23). 18 sp. Philippines.

Prochilus, Albers, 1860. Shell subperforate, ovately pyramidal or subfusiform; whorls $5\frac{1}{2}$–7, rather flattened; spire pyramidal; columella slightly arcuate; aperture narrow, oblong-ovate; peristome somewhat thickened, widely expanded, and slightly reflected. *H. virgata*, Jay. 8 sp. Philippines.

BULIMUS, Scopoli, 1787.

Etym.—? *Bou'imos*, extreme hunger (in allusion to its voracity!); typographical error for Bulinus, Adanson.

Syn.—Bulinus, Brod.

Distr.—323 sp. Mostly South American.

Shell oval-oblong or turriculated, solid, subperforate or imperforate; whorls few, the last ventricose and large, aperture longitudinal; columella widened, rarely plicate; peristome thickened, reflected; the lips usually joined by a callus. Animal similar to Helix; jaw simple, with parallel ribs (xiii, 60).

BORUS, Albers, 1850. Shell solid, subimperforate, oval or oval-oblong; whorls five or six, covered by a yellowish epidermis, the last ventricose; aperture oval-oblong; columella nearly straight; peristome thickened, reflected; lips united by a callus; columellar lip dilated, reflected. 33 sp. South America. *B. oblongus*, Müll. (xcvii, 16). *B. ovatus*, Müll., which attains a length of six inches, is sold in the markets of Rio Janeiro; it oviposits amongst dead leaves; the eggs have a white calcareous shell, are as large as those of the pigeon, and are eagerly sought for food by the negroes (xvii, 100). Borus contains the largest species of any group of Bulimus.

ORPHNUS, Albers, 1850. Shell imperforate, elongated-oval, solid; whorls seven or eight, with bordered sutures; aperture oblong-oval; columella usually plicate, callous; peristome thick-

ened; lips united by a thin callus; columellar lip subdilated. *B. Taunaysii*, Fer. 20 sp. South America.

DRYPTUS, Albers, 1850. Shell rimate, ovate or ovate-oblong; epidermis marbled, fuscous; whorls 5–6, oblique, the last large, ventricose, upper ones costulate; aperture oblong-ovate, columella twisted or plicate; peristome scarcely thickened, expanded, reflected, the margins joined by a callus. *B. fulminans*, Nyst. (xcviii, 24). 20 sp. Northern South America.

PACHYOTUS, Beck, 1837. (Chilonopsis, Fischer de Waldheim, 1848.) Shell perforate, oval, apex acute; whorls four or five, the last ample, the upper ones usually plicate at the suture; aperture auriculiform; columella tortuous; peristome very wide, thick, reflected. *B. Swainsoni*, Pfr. (xcvii, 12). 8 sp. South America.

STROPHOCHEILUS, Spix, 1827. (Coniclus, Albers, 1850.) Shell subperforated, oval-oblong; aperture oval or subauriculiform; columella tortuous, plicate above; peristome widely reflected; the lips united by a thin callus; columellar lip dilated, reflected. *B. Milleri*, Sowb. (xcvii, 15). 8 sp. Brazil.

CARYODES, Albers, 1850. Shell solid, imperforate, oblong-oval; whorls five, plicate at the suture; aperture oval, angular above, half the total length; peristome simple, obtuse; lips united by a callus; columellar lip thickened, reflected. *B. Dufresnii*, Leach (xcix, 60). 4 sp. Australia, Tasmania.

LEUCOTÆNIUS, Albers, 1860. Shell perforated, ovate-acute, thick; spire conical with rather obtuse apex; whorls seven, planulate; columella straight, thickened, slightly receding; aperture acutely ovate; peristome simple, margins joined by a heavy callus, columellar margin thickened, dilated and reflected. *B. Favannii*, Lam. 3 sp. Seychelles, Madagascar.

LIPARUS, Albers, 1850. Shell slightly perforated, oval, conic; spire a little obtuse; whorls 6–8, the last three-fourths the total length; aperture oval; peristome simple, sharp; columellar lip narrow, dilated above and reflected. *B. atomatus*, Gray. 20 sp. Australia.

PACHNODUS, Albers, 1860. Shell perforate, very rarely imperforate, ovate, conical, thin, striate or decussate; apex rather acute; whorls 5–6½, the last ventricose, nearly the length of the spire; aperture ovate or ovate-oblong; peristome simple, thin, the columellar margin dilated, reflected, free. *B. tumefactus*, Reeve (xcix, 61). 17 sp. Africa, Madagascar, Seychelles.

OVELLA, Pfeiffer, 1878. *B. Socotrensis*, Pfr. Socotora.

RHACHIS, Albers, 1850. (Achatinelloides, Nevill.) Shell perforated, oval or conical; whorls 5–8, the last sometimes angulated; aperture oval; peristome simple, sharp; columellar lip dilated, reflected, sometimes folded. *B. punctatus*, Anton (xcix, 62). 40 sp. E. and W. Africa, Mauritius, India, East Indies.

CERASTUS, Albers, 1860. Shell rimate, ovate, costulate or striulate, thin, corneous; whorls 6–7, somewhat convex, the last as long as the spire; aperture rounded-ovate; peristome reflected, with approaching margins joined by a thin callus. *B. distans*, Pfr. 13 sp. India, E. Africa.

HAPALUS, Albers, 1850. (Harpalus, Austin, 1872.) Shell imperforate, elongated, very thin, transparent; whorls six or seven, the last more than half the total length; columella callous, twisted above; aperture oval, angular above; peristome simple, sharp; outer lip arcuated above. *B. Grateloupi*, Pfr. 17 sp. India, East Indies, Philippines, Guinea, etc.

RAPHIELLUS, Pfeiffer, 1855. *B. achatinellinus*, Forbes. Galapagos.

BULIMULUS, Leach, 1814.

Syn.—Peristoma, Kryn., 1833. Zebrina, Held, 1837.

Distr.—545 sp. Tropical America.

Shell oblong, aperture longitudinal, edentulate, peristome thin, margins unequal; columella integral. Jaw arcuate, closely plicate. Lingual membrane (of *B. dealbatus*) broad, central teeth tricuspid, the median cusp very long; laterals bicuspid; the dentition varies in the different groups.

The following sections form the subgenus:—

GONIOGNATHMUS, Crosse and Fischer, 1875. It is characterized by a jaw having plications that are angulated in the centre, and by lingual teeth with narrow inner cuspidation, nearly as long as the median cusp, which is obtuse and broad.

Eudioptus, Albers, 1860. Shell imperforate, ovate or ovate-oblong, smooth, shining, pellucid, thin; whorls 5–6, the last exceeding the spire; aperture ovate or ovate-oblong; columella strict, thin; peristome acute, simple. *C. pseudosuccinea*, Moric. 6 sp. South America.

Plectostylus, Beck, 1837. Shell imperforate, thin, translucent, conic-oval; spire acute; columella intrant, slim; peristome thin, sharp. *B. Chilensis*, Lesson (xcviii, 27). 18 sp. South America.

Drymæus, Albers, 1850. (Hamadryas, Albers, 1850.) Shell perforated or umbilicated, oblong, lightly striate or rugose; spire elongated, sharp; whorls seven or eight; aperture oblong-oval; columella subtortuous; peristome simple; columellar lip reflected. *B. xanthostomus*, d'Orb. (xcviii, 28). 100 sp. Mexico, Central and South America, West Indies.

Leiostracus, Albers, 1850. Shell thin, perforated, oblong-conic, shining; spire elevated, apex acute; whorls seven or eight; aperture oval or oblong-oval; peristome thin, more or less expanded; columellar lip dilated, reflected. *B. Mexicanus*, Lam. (xcvii, 20). 38 sp. Florida, West Indies, Mexico, So. America.

Anctus, Albers, 1860. Shell rimate, ovate-conical, thin, striate, white, strigate with brown; whorls seven, rather flat, the last compressed in front; aperture narrowly oblong, vertical, peristome shortly reflected, the margins parallel. *B. anchistoma*, Wagner (xcviii, 29). Brazil.

Mesembrinus, Albers, 1850. Shell subimperforate, or perforation covered, oval-conic, longitudinally striate or a little rugose; whorls six or seven; aperture oval-oblong; columella subtortuous; peristome simple, sharp; columellar lip more or less dilated, reflected. *B. virgulatus*, Fer. (xcviii, 30). 81 sp. Lower California, Mexico, Florida, W. Indies, Central and So. America.

Mormus, Albers, 1860. Shell rimate, oblong-conical, striate or costulate, thin, white, usually fuscously variegated; whorls six or seven, the upper ones somewhat flattened, the last rather tumid; aperture about half the length of the shell, subovate; peristome simple, the columellar margin dilated and reflected. *B. papyraceus*, Mawe (xcviii, 32). 43 sp. L. California, Mexico, Central and South America.

Scutalus, Albers, 1850. Shell perforated or umbilicated, oval-conic, striated, granulated, somewhat hirsute; whorls 4–7, the last ventricose, somewhat narrowed at the base; aperture oblong-oval; peristome expanded, usually reflected, a little thickened within. *B. thamnoicus*, d'Orb. (xcviii, 33). 28 sp. L. California to So. America.

Pyrgus, Albers, 1850. Shell turreted; whorls nine, the last being a third of the total length; aperture oval; peristome simple, thin; columellar lip reflected above. *B. turritus*, Brod. Peru.

Ataxus, Albers, 1850. Shell umbilicated, oval-conic; whorls six, the last compressed and angular around the umbilicus, which is very large; aperture narrow, oblong, subangular at the base, about one-third the length of the shell; peristome simple; lips closely approaching at their extremities; columellar lip straight, expanded above. *B. umbilicaris*, Soul. (xcvii, 21). 5 sp. So. America.

Eurytus, Albers, 1850. Shell imperforate, thin, oval-oblong; whorls four or five; aperture rather longer than the spire, oblong-oval; columella arcuated; peristome subreflected; lips united by a thin callus. *B. Cathcartiæ*, Reeve (xcviii, 25). 33 sp. South America.

Oxycheilus, Albers, 1850. Shell thin, pellucid, shining, subimperforate, subfusiform, apex acute; whorls six or seven; aperture oblong-oval, shorter than the spire; columella nearly straight, slim; peristome simple; columellar lip reflected. *B. Hanleyi*, Pfr. (xcvii, 17). Brazil.

Peronæus, Albers, 1850. Shell perforated or fissured, oblong-turreted or subulate; whorls 8–11, convex; aperture oblong or

oval, a third of the length of the shell; columella intrant or a little arcuated; peristome simple, expanded; columellar lip dilated. *B. montivagus*, d'Orb. (xcviii, 36). 26 sp. South America.

Otostomus, Beck, 1837. Shell perforated, pyramidal, thin; whorls four or five, the last angulated with a flattened base; aperture elongated, oblique, subtriangular; peristome reflected, the lips joined by a callus. *B. auris-leporis*, Brug. (xcvii, 13). 9 sp. South American.

Navicula, Spix, 1827. *B. navicula*, Wagner (xcvii, 14). Brazil.

Semiclausaria, Pfeiffer, 1855. *B. semiclausus*, Pfr. N. Grenada.

Plekocheilus, Guilding, 1828. (Auricula, Swains., 1840. Caprella, Guild., 1825.) Shell scarcely umbilicated, oval, fusiform; aperture elongated-oval, angulated above; columella with a large fold; peristome thick and wide. *B. auris-Sileni*, Born (xcvii, 18). 28 sp. South America, West Indies.

Goniostomus, Beck, 1837. Shell narrowly perforate, fusiform or oblong-conic, the last whorl attenuated to the base; aperture oblong, angulated at its extremities; columella arcuated, subplicate; peristome reflected. *B. goniostomus*, Fer. (xcvii, 10). Brazil.

Anthinus, Albers, 1850. Shell narrowly perforated, oblong-conic; spire turriculated; whorls six or seven, the last as long as the spire; aperture oval-oblong, violet-tinted within; columella dentate or plicate; peristome wide; columellar lip expanded. *B. Myersii*, Sowb. (xcvii, 11). 5 sp. South America.

The following groups form the subgenus :—

ORTHOTOMIUM, Crosse and Fischer, 1875. It is American, and is characterized by vertical folds on the jaw, which are narrower in the centre; inner cusp of the teeth very short.

Leptobyrsus, Crosse and Fischer, 1875. *B. spirifer*, Gabb. Lower California.

Thaumastus, Albers, 1860. Shell imperforate or rimate, conically oblong, striulate, white strigated with fuscous; aperture oblong-oval, usually not half the length of the shell; columella distinctly twisted; peristome obtuse, simple or shortly expanded, columellar margin reflected, more or less appressed. *B. Hartwegi*, Pfr. (xcviii, 31). 47 sp. Southern United States, Mexico, West Indies, South America.

Globulinus, Crosse and Fischer, 1875. *B. sufflatus*, Gould. 2 sp. Lower California.

Rhinus, Albers, 1860. Shell perforated, conical or oblong-conical, corneous, the epidermis mostly pubescent; whorls 6–7; aperture semioval; columella dilated, subtwisted; peristome shortly reflected, white. *B. heterotrichus*, Moric (xcviii, 26). 9 sp. Brazil, Venezuela, Ins. Trinidad.

Leptomerus, Albers, 1850. Shell thin, subperforated or very rarely imperforate, oval or oblong-conic; whorls 5–7, slightly inflated below; aperture oval or oblong, shorter than the spire; columella usually subarcuated; peristome simple, thin and sharp; columellar lip a little reflected. *B. Meridanus*, Pfr. (xcvii, 19). 52 sp. South and Central America, West Indies.

Næsiotus, Albers, 1850. (Omphalostyla, Schlütt., Ads., 1855.) Shell subperforate, oval-conic or oblong-turreted, longitudinally striated; whorls 6–8; aperture oblong, angular at base, one-third the length of the shell, columella vertical; peristome simple, sublabiate within; lips subparallel, united by a small callus; columellar lip dilated above. *B. rugiferus*, Sowb. (xcviii, 35). 16 sp. Galapagos Isles.

Rhabdotus, Albers, 1850. Lip not expanded nor reflected. *B. dealbatus*, Say (xcviii, 34). 65 sp. Alabama, L. Cal., Mexico to South America.

Pleuropyrgus, Martens. Shell imperforate, turreted, rather solid, with obtuse ribs; whorls fifteen, convex; aperture semi-oval; peristome simple, the margin shortly expanded. *B. Chemnitzioides*, Forbes. Galapagos Isles.

BOSTRYX, Troschel, 1847. Shell turreted, scalariform, with wide umbilicus; whorls six, the first four regular, the last two shouldered, bicarinated; aperture subquadrangular; peristome simple or slightly expanded, continuous. *B. solutus*, Troschel (xcvii, 22). 5 sp. South America.

PLACOSTYLUS, Beck, 1837. Shell imperforate, oblong, conical, longitudinally striate; last whorl longer than the spire; aperture oval-oblong, irregular, angular above; columella a little arcuated, callous; columellar lip wide, peristome thick, lips united by a wide callus, shining and usually dentate or tuberculate. *B. insignis*, Petit (xcvii, 6). 58 sp. Australasian and Polynesian.

Euplacostylus, Crosse. Edge of aperture thickened. Animal with hinder part of body obtuse. *B. fibratus*, Martyn. Terrestrial. New Caledonia, Solomon's and Fiji Isles.

Charis, Albers, 1850. *B. fulguratus*, Jay. Fiji Islands.

Apastus, Albers, 1850. Shell imperforate, fusiform, thin, diaphanous, lightly striate; whorls six, rapidly enlarging, the last longer than the spire; aperture oval-oblong, rounded at the base; columella subarcuated; peristome labiate, reflected, lips united by a thin callus. *B. miltocheilus*, Reeve (xcvii, 7). Solomon Isles.

AMPHIDROMUS, Albers, 1850. (Beddomea, Nevill.) Shell dextral or sinistral, perforate or covered, ovate-conical or oblong-ovate; whorls 6–7½, scarcely convex; columella dilated, twisted, receding; aperture oblong, semiovate; peristome thickened, expanded, reflected, outer margin arcuate. Jaw feebly ribbed; dentition like Orthalicus. *B. perversus*, Linn. 47 sp. Java, Siam, etc.

BULIMINUS, Ehrenb., 1831.

Distr.—350 sp. Old world.

Shell solid, rimate, oblong-conic or fusiformly cylindrical, apex horny, rather obtuse, last whorl shorter than the spire; aperture small, obliquely oval; peristome straight, labiate within, simple or with teeth, right margin rather expanded, the columellar reflexed and patulous.

Animal similar to Bulimus. Jaw arcuated, finely longitudinally striate; dentition like Helix.

Petræus, Albers, 1850. Shell oblong-conical or subcylindrical; whorls 6–8; aperture oval or oblong-oval; columella folded; peristome thick, sometimes reflected, the extremities approaching, usually united by a callus. *B. labrosus*, Oliv. (xcix, 63). 32 sp. Greece, Asia Minor, Turkestan, Arabia, E. Africa, India.

Ena, Gray, 1840. (Merdigerus, Albers, 1850. Peristoma, Kryn., 1833. Napæus, Albers, 1850.) Shell oval-oblong or subcylindrical; whorls 7–9, the last about half the total length; aperture oval; peristome labiate within; columellar lip dilated. *B. badiosus*, Fer. (xcix, 64). 80 sp. Warm regions of the eastern hemisphere.

Leucochiloides, Pfr., 1878. *B. cænopicta*, Hutton (xcix, 65). 10 sp. India, Arabia, Senegal, etc.

Cylindrus, Fitz., 1833. *B. obtusus*, Drap. Austrian Alps.

Medea, Boettger, 1883. Ovately conical, profoundly rimate, thin, shining; white or corneous, sometimes with a median fuscous zone; whorls spirally lineolated, the last rounded at base; aperture large, with remote margins, sometimes joined by a slight callus. *B. Raddei*, Kobelt. Caucasus.

Pupoides, Pfr., 1854. *B. marginatus*, Say. 7 sp. United States, West Indies, Mazatlan.

Mastus, Beck, 1837. Shell cylindrical, subpupiform, subperforate, apex obtuse; whorls numerous; aperture small, rounded-oval; columella short, straight, peristome labiate within. *B. polygyratus*, Reeve (xcix, 66). 11 sp. India, Zanzibar, etc.

Zebrina, Held, 1837. (Brephulus, Beck [part], 1837. Bulimulus, Risso, 1826. Adams, 1855.) Shell solid, rimately perforated, oblong-conic or fusiformly cylindrical, apex horny, rather obtuse, last whorl shorter than the spire; aperture small, obliquely oval; peristome straight, labiate within, dentate, right margin rather expanded, the columellar reflexed and patulous. *B. fasciolatus*, Fer. (xcix, 67). *B. Tournefortianus*, Fer. (xcix, 68). 36 sp. Eastern Europe, W. Asia.

Chondrula, Beck, 1837. (Chondrus, Cuv., 1817. Jaminia, Risso, 1826. Gonodon, Held, 1837. Eucore, Agassiz, 1837. Mirus, Albers, 1850.) Shell rimate, ovate-oblong, apex acuminated; whorls 7–9, the last nearly one-third of the length;

aperture semioval, internally generally contracted; peristome labiate, furnished with numerous teeth, or very rarely simple; sometimes the apertural paries is unidentate at the external angle. *B. quinquedentatus*, Mühlf. (xcix, 69). 60 sp. Mostly Eastern Europe and W. Asia.

ODONTOSTOMUS, Beck, 1837. (Cyclodontina, Beck [part], 1837.) Shell rimately perforate, cylindrically fusiform; spire elongate, turreted; last whorl compressed at the base, often externally scrobiculate; aperture oblong, contracted, with from 3 to 6 teeth; parietal wall with an intrant lamella; peristome expanded, reflexed, the margins approximate, joined by a thin callus. *B. Pantagruelianus*, Mor. (xcvii, 8). 35 sp. Brazil, Argentine Republic.

Macrodontes, Swains., 1840. Shell bulimiform; spire longer than the aperture, which is surrounded with large teeth; lips united, the outer large, dilated, reflected. *B. odontostomus*, Sowb. 3 sp. Brazil, Buenos Ayres.

Plagiodontes, Döring. Shell ovate, aperture with many teeth and a transverse plait behind; jaw strongly ribbed. La Plata to Patagonia, So. America. *P. dentatus*, Wood. *P. dædaleus*, Desh.

TOMIGERUS, Spix, 1827.

Distr.—*T. principalis*, Sowb. = *gibberulus*, Burrows (xcvii, 9). 5 sp. Brazil, Venezuela.

Shell perforate, turbinate-globular, last whorl ventricose, aperture rounded or triangular, turned upward, vertical; peristome expanded or reflected, the lips joined by a callus; interior of aperture contracted by numerous entering lamellæ.

ANOSTOMA, FISCHER, 1807.

Syn.—Tomogerus, Montf., 1810. Angystoma, Schum., 1817.

Distr.—5 sp. Brazil. *A. globulosa*, Lam. (xciii, 1).

Shell orbicular-depressed; spire convex, more or less obtuse; last whorl abruptly turned upwards at the aperture, which thus faces dorsally, has reflected peristome, thickened and dentate within, its extremities connected by a callus, which is also dentate. Jaw smooth.

Ringicella, Gray. Peristome perforated by a small canal. *A. globulosa*, Lam.

BOYSIA, Pfeiffer, 1850.

Syn.—Hypostoma, Albers, 1850. Hypostrema, Albers, 1860.

Distr.—*B. Bensoni*, Pfr. (c, 98). Bengal.

Shell conic-globose, thin, umbilicus a shallow slit, last whorl ascending on the spire; aperture oblique, subrotund, without teeth, turned upwards; peristome thick, not reflected, the extremities joined by a callus.

STROPHOSTOMELLA, Fischer, 1883. Shell lenticular, with arcuated umbilical slit; last whorl carinated, ascending, applied to the penultimate; aperture semiorbicular, a little dilated transversely; peristome continuous, reflected; columella thickened. *B. Reussi*, Stoliczka. Cretaceous of Gosau.

ANASTOMOPSIS, Sandberger, 1870.

Distr.—*A. rotellaris*, Matheron. Cretaceous.

Shell plane above, periphery carinated, convex and profoundly umbilicated below; whorls narrow, numerous, the last one ascending so that the falciform aperture is in the plane of the spire; interior sharply lamellate.

LYCHNUS, Matheron, 1832.

Syn.—Anadromus, Sandberger.

Distr.—Cretaceous; France and Spain. *L. Matheroni*, Requien.

Shell discoidal, convex at base, with arcuated umbilical slit; whorls of the spire few, narrow, forming a small column, last whorl very large, ascending and partially covering the spire to the apex, then deflected downwards; aperture on the side of the base, horizontal, oval, transverse, without teeth; peristome reflected.

HYPSELOSTOMA, Benson, 1856.

Syn.—Tanystoma, Benson, 1856.

Distr.—3 sp. Burmah. *H. tubiferum*, Bens. (c, 99). Ava.

Shell convolute, conoidal, umbilicus open, last whorl free, protracted, turned upwards; aperture trumpet-like and dentate; peristome horizontal, expanded.

PARTULA, Fer., 1819.

Distr.—70 sp. Central Polynesia. *P. faba*, Mart. (xcix, 70). *P. Otaheitana*, Brug. (xcix, 71).

Shell dextral or sinistral, oblong-ovate or conic-ovate; outer lip reflected; aperture auriform or ovate, more or less oblique, occasionally contracted by the wide and often dentate columella, and by a labial or pillar-tooth; surface with very minute spiral striæ, which are foveate at the apex.

Viviparous. Jaw very thin, of oblique lamellæ sharply angulated at the centre; lateral teeth tricuspidate, the inner cusp short, marginals narrow, arcuate, tricuspidate.

Dr. W. D. Hartman, who has made a special study of this genus, proposed in 1881 a number of subgenera: Nenia, Astræa, Clytia, Ilia, Œnone, Helena, Pasithea, Ægu, Echo, Latia, Evadne, Harmonia, Matata and Sterope. Some of these names are preoccupied by other authors. I give no diagnoses for the reason

that I believe these groups have but slight value; an opinion in which Dr. Hartman now coincides.

PELTELLA, Web. and Van Ben., 1836.

Syn.—Pectella, Peltellina, Gray, 1847, Gæotis, Shuttlew., 1854.

Distr.—Brazil, Porto Rico. *P. palliolum*, Fer. (ci, 43).

Animal limaciform, rounded above, flat below, sides widely expanded; tentacles simple; mantle small, oval, posterior, concealing a shell; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; distinct locomotive disk? external respiratory and anal orifices on the right anterior margin of the mantle; orifice of combined genital organs behind and below right peduncle.

Shell internal, sigaretiform, rudimentary, small, flat, oblong, subspiral, nucleus infero-posterior.

Jaw ribbed. Lingual ribbon with peculiar long, narrow teeth, centrals, laterals and marginals bluntly tricuspid.

From Ferussac's figure 4 it appears probable that the shell may be more properly described as external, but covered by an accessory process of the mantle.

The South American forms are said to be most frequently found partly buried in damp earth in the woods of Brazil; the West Indian species crawl at night and in the morning on the trunks and foliage of Bananas or Plantains.

PELLICULA, Fischer, 1855.

Distr.—3 sp. West Indies. *P. depressa*, Rang (c, 39). Guadaloupe.

Shell like Philine. Last whorl and aperture embracing nearly the whole shell, the spire being minute and inconspicuous; inferior tentacles rudimentary.

Animal not able to retire within its shell, which occupies the middle of the back. Jaw like Amphibulima.

BINNEYA, J. G. Cooper.

Syn.—Xanthonyx, Cr. and Fisch.

Distr.—3 sp. Mexico, and islands of the southern coast of California. *B. notabilis*, Cooper (xcii, 73).

Animal sublimaciform, blunt before, tapering behind; tentacles simple; mantle subcentral, covered by a shell, with an anterior expansion; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; a distinct locomotive disk; external respiratory and anal orifices on the right posterior margin of the mantle, under the peristome of the shell; orifice of combined genital system behind and below the right eye-peduncle. Shell external, paucispiral, auriform, not enclosing

the animal. Jaw ribbed. Lingual membrane with tricuspid central teeth, bicuspid laterals, and quadrate marginals.

The animal has the peculiarity during estivation of forming a testaceous covering extending from the peristome over the parts not protected by the shell.

The body is not attached its whole length to the foot, the viscera forming a turbinate spiral mass, partially protected by the shell.

AMPHIBULIMA, Blainv., 1825.

Distr.—8 sp. West Indies. *A. patula*, Brug. (c, 37).

Shell oval, ventricose, rugose, membranaceous, paucispiral; spire small; last whorl very large, angular; aperture very large, rounded-oval; peristome acute.

Animal capable of withdrawing into its shell. Jaw plicate, the plicæ angulated at the centre; central tooth very long, middle cusp of the lateral teeth swollen; marginals short, tricuspidate.

RHODONYX, Fischer, 1873. (Mastogyra, Ancey, 1881.) *A. rubescens*, Desh. Guadeloupe. Shell resembling Succinea.

SIMPULOPSIS, Beck, 1837. Shell semioval, very thin, membranaceous, paucispiral, the last whorl ventricose; aperture very large, oblique, rounded-oval; columella arcuated; peristome simple, sharp. *A. rufovirens*, Moric (c, 38). 20 sp. Brazil, West Indies.

Platysuccinea, Ancey, 1881. Shell approaching Succinea. *S. Portoricensis*, Shuttl.

FAMILY ORTHALICIDÆ.

Shell bulimiform, thin, ventricose. Jaw with a triangular median portion, and on either side oblique imbricating plates, free in front and adhering behind (xiii, 58). Central and lateral teeth quadrangular at base, with broad central and rudimentary lateral cusps; marginal teeth bicuspidate. Living upon trees, and secreting during the dry season a thick coriaceous epiphragm.

ORTHALICUS, Beck, 1837.

Distr.—32 sp. Tropical America. *O. Bensoni*, Reeve (xcviii, 37).

Shell imperforate, oval, conic; whorls seven or eight, the last longer than the spire; aperture rounded-oval; columella nearly straight, but little thickened; peristome simple; lips united by a thin callus.

Sultana, Shuttl., 1856. Inflated, apex pitted. *O. Dennisoni*, Reeve.

Zebra, Shuttl., 1856. Narrower, apex smooth. *O. undata*, Brug. (xcviii, 38).

Corona, Albers, 1850. Shell usually sinistral, oval-oblong; spire elongated, subturreted, summit obtuse; whorls eight, the last two-thirds the total length; aperture semioval; columella tortuous, plicate, callous above, slim at the base, truncate; peristome simple, sharp; outer lip uniting with the columella at a sharp angle. *O. regina*, Fer.

Orthalicinus, Crosse and Fischer, 1875. *O. fasciata*, Müll. (xcviii, 39). Cuba, Florida.

Calycia, Adams, 1865. *O. crystallina*, Reeve. Waigiou, Malay Archipelago.

LIGUUS, Montfort, 1810. (Chersina, Beck [pt.], 1837. Pseudotrochus, Mörch, 1852.) Shell imperforate, solid, elongately conical, apex acuminate, variously fasciate with gay colors; whorls 7–8, the last about one-third the total length; columella straight, in the adult distinctly truncate; aperture lunately oval, subangulate; peristome simple, acute, the margins joined by an entering callus. *O. virginea*, Linn. (xcviii, 40). 6 sp. West Indies.

Porphyrobaphe, Shuttl., 1856. Shell imperforate, oblong, solid, usually plicately striate, apex obtuse; whorls 6–8, the last ventricose; columella thick, plicately twisted; aperture oblong-oval; peristome thickened, expanded-reflected, margins united by a thin callus. *O. iostoma*, Sowb. 12 sp. So. America.

FAMILY ACHATINIDÆ.

Shell moderately thick, with more or less elongated spire; the last whorl generally ventricose; aperture large; columella truncate at the base; peristome usually simple, sharp.

Jaw finely plicate or costulate, thin; central tooth very small, laterals tricuspid, with the central cusp much the longest, marginals short, tricuspid.

ACHATINA, Lam., 1799.

Etym.—Agate-shell.

Syn.—Cochlitoma, Fer., 1819. Oncæa, Gistel, 1848.

Distr.—73 sp. Mostly African; arboreal. *A. zebra*, Chemn. (xcviii, 43).

Shell oblong-oval, with conical spire, very rarely turriculated, sometimes sinistral; whorls 6–9, the last more or less ventricose; columella tortuous, arcuated, truncate below; aperture oval, expanded below, sharply angulated behind; peristome sharp; lips united by a more or less callous shining deposit.

The Achatini are the largest of all land-shells, even exceeding the great Bulimi of the *Borus* group which replace them in the similar latitudes of South America; like them, the eggs are large, with a calcareous shell, being over an inch in length.

Homorus, Albers, 1850. Imperforate, turreted, apex obtuse,

striate or costulate; aperture oval, short, about one-third or one-fourth the length of the shell; columella arcuate, abruptly truncate; peristome simple, acute. *A. cyanostoma*, Ruppell.

PERIDERIS, Shuttleworth, 1856. (Corona, Albers [pt.], 1850.) Shell imperforate, ovately conical or oblong, apex papillary, shining, striate, decussated by very minute spiral lines, epidermis very thin; whorls 6–7, the last usually obsoletely angulated; suture wrinkled, marginate; aperture short, suboval, columella slightly twisted, obliquely subtruncate; peristome simple, acute. *A. balteata*, Gould (xcviii, 41). 18 sp. West Africa.

LIMICOLARIA, Schum., 1817. Shell perforate, conically or turreted oblong, last whorl shorter than the spire; aperture oblong, suboval; columella vertical, protracted at the base; peristome simple, thin, straight, columellar margin dilated, arcuately reflexed. *L. Æquatoria*, Rve. (xcviii, 42). 31 sp. Africa.

PSEUDACHATINA, Albers, 1850. Shell solid, oval, turriculated; whorls eight or nine, the last obtusely angular at the periphery, and exceeding half the length of the shell; columella subtortuous, a little arcuated, truncate-tuberculate below; aperture oval; peristome thick, slightly reflected; lips united by a callosity. *P. Downesii*, Gray (xcviii, 44). 7 sp. W. Africa.

COLUMNA, Perry, 1811. Shell always sinistral, much elongated, decussated, whorls oblique; constricted at suture; apex obtuse; columella callous, spirally twisted, truncate at base; peristome simple, sharp. *C. flammea*, Martyn (xcviii, 46). 4 sp. W. Africa. Fossil Achatinæ occurring in the eocene of Upper Missouri, and in the Paris basin, are referred to this group.

CHILONOPSIS, Fischer de Waldheim, 1848. Shell bulimiform, thick; aperture ear-shaped, both lips greatly thickened, the columellar lip tuberculate above, obliquely truncate below. *Bulimus auris-vulpina*, Chemn., which occurs subfossil in the island of St. Helena, is the type of this group.

STENOGYRA, Shuttleworth, 1850.

Syn.—Sira, Schmidt, 1855. Subulina, Adams, 1855.

Distr.—250 sp. World-wide, tropical and temperate regions.

Shell elongated, turriculated, whorls numerous, apex obtuse or truncate; aperture oval, small, columella thin, straight; peristome simple, sharp.

Median tooth of the radula very small; jaw thin, feebly arcuated, vertically plicate.

OBELISCUS, Beck, 1837 (= Stenogyra, restricted). Shell long, imperforate, elongate-turreted, scarcely shining; whorls 10–18, last about one-fourth the total length; columella straight, not truncate; peristome simple. *S. obeliscus*, Moric. (xcix, 31). 38 sp. West Indies, Central and South America, Natal, Philippines, etc.

RUMINA, Risso, 1826. (Orbitina, Risso, 1826. Cylindrina, Schlütt., 1838.) Shell turriculated, the adult always truncate; whorls numerous, plane, with moderately impressed suture; aperture small, oval, the peristome slightly thickened, its extremities united by a slight callus.

S. decollata, Linn. (xcix, 82, 83), is a native of the Mediterranean region of Europe; it is acclimated at Charleston, S. C.

CLAVATOR, Martens, 1860. Shell turreted-conical. not shining; flavously striate; peristome simple, obtuse. *S. clavator*, Petit. 2 sp. Madagascar.

OPEAS, Albers, 1850. Shell thin, umbilicated or imperforate, usually small, subulate, covered with striæ or small ribs; aperture oval-oblong; peristome simple, columellar lip reflected. *S. octonoides*, Ads. (xcix, 84). 63 sp. West Indies, Java, etc.

SPIRAXIS, C. B. Ad., 1850. Shell elongated, acuminate, very finely longitudinally striate; columella tortuous; peristome simple. 44 sp. India, China, West Indies, Mexico, Central America.

Euspiraxis, Pfr., 1855. Turreted, thin, striulate or costulate, shining; whorls 6–9, rather flat; aperture ovate-oblong, one-third to one-half the total length; peristome simple, acute. *S. aberrans*, Pfr. (xcix, 85).

Nothus, Albers, 1850. Shell imperforate, oblong-conic, thin, diaphanous; whorls six or more, the last about the length of the spire; columella short, doubly tortuous; columellar lip reflected; aperture small, semioval; peristome simple. *S. Salleana*, Pfr.

Lamellaxis, Strebel and Pfeffer, 1882. *S. Mexicanus*, Pfeiffer.

SUBULINA, Beck, 1837. (Macrospira, Swains., 1840.) Shell diaphanous, cylindrical, turriculated or conic-elongated, with obtuse summit; whorls numerous, slowly increasing in size; aperture oval, short, columella subarcuated and obliquely truncated at base; peristome sharp. *S. sulcatus*, Gray (xcix, 86, reversed in error). 90 sp. India, E. and W. Africa, West Indies, Mexico, Central America.

Glandinella, Pfeiffer, 1878. *S. Poeyanus*, Pfr. Isle of Pines, near Cuba.

GLESSULA, Albers, 1860. (Electra, Albers, 1850.) Shell ovate-oblong, thin, diaphanous; spire pyramidal, apex obtuse; whorls numerous, the last inflated; columella short, arcuated, abruptly truncated. *G. Ceylonica*, Pfr. (xcix, 89). 59 sp. India, East Indies, W. Africa.

MELANIELLA, Pfeiffer, 1859. Shell imperforate, costate, decussated; brownish horn-color; whorls nine, slightly convex, gradate; aperture effuse at base, ovate; columella strict; peristome simple, subcontinuous. *S. acuticostata*, d'Orb. (xcix, 87). 8 sp. Cuba, Trinidad, Florida.

LEPTINARIA, Beck, 1837. Shell oval, pellucid; columellar lip doubly toothed; outer lip smooth, sharp. *L. Cumingiana*, Pfr. (c, 92). 16 sp. West Indies, Central, and Northern South America.

FERUSSACIA, Risso, 1826.

Syn.—Pegia and Vediantius, Risso, 1826. Strobilus, Ads., 1855.

Distr.—62 sp. Mediterranean region, Canaries, Malaysia, etc. Fossil. Eocene.

Shell small, ovately fusiform, imperforate, polished, transparent, columella plicate, subtruncate; outer lip simple. Jaw thin, numerously plicate, margins crenulated.

Folliculus, Agassiz, 1837. (Euferussacia, Bourg., 1870.) Typical group. *F. Gronoviana*, Risso (c, 93). *F. Vescoi*, Bourg. (c, 94). 37 sp. Southern Europe, N. Africa, Madeira.

Pseudostreptostyla, Nevill. Pillar-lip resembling that of Spiraxis. *F. abnormis*, Nevill. So. France.

Cylichnidia, Lowe, 1854. Shell oval-fusiform, columella uniplicate; outer lip thin. *C. ovuliformis*, Lowe (c, 95). 2 sp. Madeira.

Tornatellinoides, Pfr., 1877. Resembling Tornatellina. *C. achatinoides*, Pfr. 8 sp. N. Africa, Syria, Gambier Isles.

Pseudazeca, Pfr., 1877. Resembling Azeca. *C. procerula*, Mor. 5 sp. Algiers.

Cryptazeca, Folin, 1877. Shell like Cionella, with one columellar tooth; hinder end of the foot truncate, with several unicellular glands; mantle not extended beyond the shell. *C. monodonta*, Folin. Bayonne.

Lowea, Watson. Mantle thinly spread over the outside of the shell, and extending like a tongue backwards behind the posterior corner of the aperture; tail abruptly truncate, with a mucous gland. *L. melampoides*, Watson. Madeira.

AZECA, Leach, 1818. (Agraulina, Bourg., 1858.) Shell small, oval-elliptical, corneous, smooth, polished; aperture half the total length, oval or oblong, with numerous teeth; columella compressed, callous, truncate-dentate at the base; peristome simple, obtuse, labiate within, the extremities usually united by a tubercled callus. 17 sp. Europe, Algiers, Canaries.

Azecastrum, Bourg., 1858. Typical group. *A. tridens*, Pult. (c, 96). 2 sp. Europe.

Alsobia, Bourg., 1858. *A. Paroliniana*, Webb and Bertholet. Canaries.

Hypnophila, Bourg., 1858. *A. Pupæformis*, Cantraine. 9 sp. Europe, Algiers.

Fusillus, Lowe, 1854. *A. triticea*, Lowe. 3 sp. Madeira.

Amphorella, Lowe, 1854. *A. tornatellina*, Lowe. 3 sp. Madeira.

CIONELLA, Jeffreys, 1830.

Syn.—Styloides, Fitz., 1833. Cochlicopa (part), Moquin-Tandon, 1855.

Distr.—106 sp.

Shell oblong-acuminate or ovate-oblong, striated or smooth, shining; whorls 6–7, the last rounded; aperture oval, about one-third the total length; columella short, scarcely truncated, arcuate; peristome straight, thickened within.

Zua, Leach, 1820. (Hydastes, Parr., 1849.) Shell ovate-oblong, imperforate, smooth, pellucid, glistening, dark horn-colored; whorls rather convex; aperture less than half the total length, ovate; columella more or less truncated; peristome blunt, its margins joined by a callus. *C. subcylindrica*, Linn. (xcix, 90). 9 sp. Europe, United States, Madeira, Sandwich Isles.

Hypselia, Lowe, 1854. *C. producta*, Lowe. 2 sp. Madeira, Morocco.

CÆCILIANELLA, Ferussac, 1817.

Syn.—Cecilioides, Fer., Blainv., 1817. Polyphemus, Parreyss, 1849. Cæcilianella, Bourg., 1856. Acicula, Risso, 1826.

Distr.—24 sp. Europe, N. Africa, Cape Verd Is., W. Indies, Mauritius. *C. acicula*, Müll. (xcix, 91).

Shell elongate, imperforate, polished, vitreous, white; spire turreted with rather obtuse apex; aperture about half the length of the shell; columella subarcuate, distinctly truncate; peristome simple, acute.

The Cæcilianellæ are subterranean and nocturnal in habit.

GEOSTILBIA, Crosse, 1867. Shell imperforate, small, fusiformly cylindrical, thin, hyaline; apex brusquely rounded and very obtuse; whorls few; aperture elongate-pyriform; peristome simple, slightly thickened; columellar margin with a shining, transparent, longitudinal lamina, not truncate; basal margin widely rounded. New Caledonia, India, West Indies. *C. Caledonica*, Crosse.

PYRGINA, Greef., 1882.

Distr.—*P. umbilicata*, Greef. I. of St. Thomas, W. Coast of Africa.

Shell turreted, closely wound, of twelve or thirteen whorls, in a length of 14 mill.; upper whorls with close, curved costæ, rather flat, with deep suture; last whorl with a carina and rounded basal part, with open, deep umbilicus; mouth oval, angulated: columella with a spiral fold; shell white, under a corneous epidermis.

RHODEA, H. and A. Adams, 1855.

Distr.—3 sp. New Grenada. *R. gigantea*, Mouss. (xcix, 88).

Shell elongated, cylindrical, subulate, consisting of numerous

flat whorls; last whorl concave at the base, perforated and carinated at the periphery; aperture subquadrate, small; columella thickened, arcuated, subtruncate below; outer lip thin, slightly reflected.

FAMILY ACHATINELLIDÆ.

Shell small, bulimiform, dextral or sinistral, columella plicate-truncate, lip usually thickened within.

Jaw finely striated or costulated; teeth sometimes in oblique rows, with narrow base and reflected, many-toothed margins, sometimes subhorizontal, with central and lateral teeth like Achatina, the marginals multicuspidate.

ACHATINELLA, Swainson, 1828.

Syn.—Helicter (Fer., 1819), Pease, 1862.

Distr.—300 sp. Sandwich Islands.

Shell conical, smooth, generally small, dextral or sinistral, imperforate, banded, striped and spotted with bright colors; whorls six or seven; columella short, callous or dentate at the base or in the middle, and very often tortuous; aperture small; peristome simple, not reflected, but thickened within.

Ovoviviparous. Confined to the Sandwich Islands, where they live principally among the foliage of bushes in shady places near the sea. No shells exceed these in the beauty and variety of the painting. Since the introduction of cattle into the islands they are becoming exterminated by the destruction of the foliage upon which they feed. The species being founded mostly upon the character of coloration, have been unnecessarily multiplied, as there is evidently considerable variation of coloring in the same species.

ACHATINELLASTRUM, Pfeiffer, 1854. (Achatinella, restricted.) *A. pulcherrima*, Swains. (xcix, 73). 50 sp.

PARTULINA, Pfeiffer, 1852. Shell conical, frequently sinistral; columella tortuous, not truncate; outer lip thickened within, expanded. *A. pallida*, Nutt. (xcix, 72). 9 sp.

BULIMELLA, Pfeiffer, 1852. Shell conical, frequently sinistral; columella short, not truncate; outer lip thickened within, not expanded. *A. bulimoides*, Swains. 47 sp.

NEWCOMBIA, Pfeiffer, 1852. Shell conical, turriculated, sinistral; whorls with revolving raised sharp lines; columella somewhat straight, callous; lip simple, sharp. *A. plicata*, Mighels (xcix, 78). 8 sp.

AURICULELLA, Pfeiffer, 1855. Shell subperforate, oblong-conic; apertural paries furnished with an intrant, spiral lamella; columella with the anterior plait dentiform or obsolete; peritreme a little expanded. *A. auricula*, Fer. (xcix, 74). 21 sp.

FRICKELLA, Pfeiffer, 1855. Subumbilicated, oblong, conic; a

spiral, lamellar tooth on the inner lip of the aperture; columella with a compressed fold. *A. amœna*, Pfr. (xcix, 75).

AMASTRA, H. and A. Adams, 1853. Shell generally dextral, striate or rugose, last whorl ventricose, dull-colored, brown; columella with an anterior spiral, lamelliform plication; lip slightly thickened. *A. tristis*, Fer. (xcix, 76). 22 sp.

APEX, Albers, 1860. Short conic, solid, smooth or striate; upper whorls plane, the apex acute and discolored, the others tumid, margined; aperture irregularly quadrangular, with moderate columellar tooth; the peristome thinly labiate, acute or rarely slightly expanded. *A. lugubris*, Chemn. 30 sp.

CARINELLA, Pfeiffer. Shell trochiform, carinated, coarsely striate; columella twisted and plicate; outer lip simple. *A. Kauaiensis*, Newcomb (xcix, 80).

LAMINELLA, Pfeiffer, 1852. Shell conical, turriculated; spire somewhat acute; last whorl ventricose; columella tortuous, forming a large, lamellar fold; outer lip simple, sharp. *A. picta*, Mighels (xcix, 77). 70 sp.

PERDICELLA, Pease, 1869. Shell dextral or sinistral, bulimiform, turreted or elongate-conical, imperforate, thinly striated; columella with inconspicuous or no plica; peristome simple, thin. *A. Helena*, Newcomb. 7 sp.

LABIELLA, Pfeiffer, 1852. Shell oval-conical; inner lip callous; outer lip thickened; with a callosity on the middle of its inner margin. *A. dentata*, Pfr. 6 sp.

LEPTACHATINA, Gould, 1847. Shell conical, elongated, thin, smooth, translucent; spire obtuse; aperture rounded, angular above; columella callous. *A. clara*, Pfeiffer (xcix, 79). 38 sp.

EBURNELLA, Pease, 1869. Shell solid, smooth, polished, oblong-ovate, with a twisted columellar plica; lip not thickened; apex somewhat obtuse or acute. *A. casta*, Newcomb. 9 sp.

CARELIA, H and A. Adams, 1853.

Distr.—8 sp. Sandwich Islands. *C. cochlea*, Reeve (xcviii, 45).

Shell elongated, turriculate; whorls flattened, sometimes slightly shouldered; columella strongly arcuated and contorted; aperture small.

TORNATELLINA, Beck, 1837.

Syn.—Elasmatina, Petit, 1837. Lamellina, Pease, 1860. Lamellaria, Liardet, 1876.

Distr.—35 sp. Polynesia, Australasia, Juan Fernandez, Mauritius. *T. globosa*, Petit (c, 97).

Shell turbinate-oval or subtrochiform, fragile, pellucid; columella tortuous, truncated; columellar lip with one or several teeth; outer lip sharp, plicate within.

Family CYLINDRELLIDÆ.

Shell cylindrically turriculated, many-whorled, the last whorl more or less detached at the aperture; apex of the spire usually truncated.

Jaw thin, formed of oblique plications, angular in the middle; radula narrow, the central tooth very narrow, the laterals leaf-like, oblique, the marginals sometimes resembling the laterals, but smaller, sometimes very short, rudimentary.

Cylindrella, Pfeiffer, 1840.

Distr.—193 species. Tropical America.

Shell convex-cylindrical, many-whorled, truncate at the apex; whorls slowly increasing in size, the later ones frequently constricted, the last partly or wholly free, angulated or subcarinated; aperture subcircular, peristome reflected, continuous.

The true Cylindrellæ are chiefly represented in the islands of the West Indies. They have been distributed, with regard to the radula, in the following manner:—

Group 1. Cylindrella proper; only two lateral teeth on each side, the following "marginal" teeth of very different form and in various numbers. *C. Trinitaria*, Pfr., *C. gracilis*, Wood, *C. Bahamensis*, Pfr., *C. costata*, Guilding, *C. Agnesiana*, Adams, and *C. Brooksiana*, Gundlach. This division contains the groups called Casta, Trachelia and Mychostoma by Albers.

Group 2. Callonia, Crosse and Fischer: more than two lateral teeth, marginal teeth not very different; median tooth very narrow. *C. Ellioti*, Poey.

Group 3. Thaumasia, Albers: more than two lateral teeth; marginal teeth not differing from them. *C. perlata*, Gundl., *C. Vignalensis*, Wright, *C. brevis*, Pfr., *C. scaeva*, Gundl., *C. rosea*, Pfr., *C. sanguinea*, Pfr.

I question the propriety of separating the groups indicated above by slight differences in dentition; so few observations have been made, and the characters are also so mutable, that it appears more natural as well as more convenient to continue to employ the old subgeneric names with diagnoses made up principally from characters of the shell.

Anoma, Albers, 1850. Shell elongated, turriculated, fusiform, subtruncated, attenuated to the summit; twelve to eighteen whorls, the last not free or declining, carinated at the base; aperture rounded-oblong, expanded in front; peristome thin, expanded. *C. tricolor*, Pfr. (xcix, 47). 14 sp. Cuba, Jamiaca, Mexico.

Thaumasia, Albers, 1850. (Urocoptis, Beck [pt.], 1837.) Shell rimate, ovately cylindrical or subventricose; whorls 8–10, regularly increasing, the last scarcely free, obsoletely carinate;

peristome free, reflected. *C. decollata*, Nyst. 30 sp. Hayti, Jamaica, etc.

APOMA, Beck. 1837. (Casta, Albers, 1850.) Shell sinistral, cylindrical, subulate; whorls numerous, oblique, the last scarcely free, carinated at the base; aperture oblong, circular, peristome expanded. *C. gracilis*, Wood (xcix, 48). 3 sp. Jamaica.

CALLONIA, Crosse and Fischer, 1870. Shell subulate, truncated, many-whorled, whorls ribbed across; last whorl free, declining, angulated; aperture subquadrangular; peristome simple, expanded. *C. Elliotti*, Poey (xcix, 49). Cuba.

GONGYLOSTOMA, Albers, 1850. Shell cylindrically fusiform or conically turreted, apex attenuated, costulately striate; whorls 9–20, the last more or less protracted, narrow, sometimes obsoletely angulate; aperture circular; peristome expanded. *C. elegans*, Fer. 85 sp. Mostly Cuba and Jamaica.

MYCHOSTOMA, Albers, 1850. (Brachypus, Guild, 1828. Brachypodella, Beck, 1837. Brachypodisca, Agass., 1847.) Shell subcylindrical or subulate, truncate; whorls 9–17, the last free, declining; aperture subquadrangular; peristome expanded. *C. collaris*, Fer. (xcix, 51). 27 sp. West Indies.

STROPHINA, Mörch, 1852. Shell turriculated, cylindrical, subventricose, umbilicated, summit truncate; whorls convex, obliquely plicate; columella angulated at the base; subarcuated; aperture subquadrangular. *C. Laterradii*, Grat. (xcix, 52). Hayti.

CIRROBASIS, Conrad, 1874. *C. venusta*, Conr. (xcix, 53). Tertiary. Pebas, Upper Amazon.

TRACHELIA, Pfeiffer, 1855. (Acera, Ads. [pt.], 1855.) Shell fusiform, not rimate, apex attenuate, somewhat truncated; whorls 18–24, the last free, protracted; aperture oblique, circular; peristome expanded. *C. porrecta*, Gould (xcix, 50). 33 sp. Cuba, and other W. I. Islands, Central America.

METASTOMA, Strebel and Pfeffer. Not truncated; last whorls partly free, turned horizontally inwards, concealing the perforation. *C. Rœmeri*, Pfr. Mexico.

BOSTRICHOCENTRUM, Strebel and Pfeffer. Columella tubular, surrounded by a thick, solid, rope-like thickening. *C. Tryoni*, Pfr. (xcix, 54). Mexico.

HOLOSPIRA, Martens, 1860. (Acera, Albers, 1850.) Shell rimate, turreted or fusiform, apex conical, *not* truncated; whorls 11–14, the last barely or not at all protracted, base carinated; columella plicate; aperture quadrangular; peristome free, expanded. Erected by Crosse and Fischer into a distinct genus in the family Pupidæ, the teeth of the radula being in transverse rows and tricuspidate, similar to Helix; the jaw very thin and smooth. *C. Pfeifferi*, Menke; Texas, Mexico. 13 sp. Mexico, Texas, on Cactus.

EPIROBIA, Strebel and Pfeffer. Distinct from Holospira by the columella being perpendicularly costulated, but without spiral plait. *C. Berendti*, Pfr. Mexico.

EUCALODIUM, Crosse and Fischer, 1868. Shell subrimate, turreted, cylindrelliform, widely truncate; last whorl slightly free, more or less carinate; columella with a plica, not reaching the aperture. Jaw arched, finely striated, with a short laminar appendix, recalling that of Succinea; teeth of the radula in transverse rows, tricuspidate, similar to those of Helix. *C. Ghiesbreghti*, Pfr. (xcix, 55). 20 sp. Mexico.

ANISOSPIRA, Strebel and Pfeffer. Shell somewhat like Eucalodium, columella tubular with external plait. *C. Liebmanni*, Pfr. (i, 12, 13).

CŒLOCENTRUM, Crosse and Fischer, 1872. Pillar a hollow glossy tube; shell resembling Eucalodium, externally ribbed. *Cylindrella turris*, Pfr. (xcix, 56). 8 sp. L. California, Mexico, Guatemala.

BERENDTIA, Crosse and Fischer, 1869. Shell turriculated, dextral, with obtuse summit and numerous whorls, the last one descending and detached in front; peristome continuous, widely reflected; columella simple, without lamellæ; aperture semicircular, without plications; no clausilium; umbilicus deeply slit.

General shape of shell like Clausilia, but without plaits or clausilium in the interior; jaw very arcuate, with nine strong ribs; radula with a somewhat smaller tricuspid median tooth and thirty lateral and marginal teeth, the first tricuspid, the latter bicuspid. Except the jaw, there are many points of resemblance between Berendtia and Eucalodium. *C. Taylori*, Pfr. (*C. Newcombiana*, Gabb.) Lower California.

FASCINELLA, Stache, 1870.

Distr.—*F. eocenica*, Stache. L. Eocene; Albona.

Shell smooth, thin, turriculated, small; axis perforated; spire sharp; last whorl small, retracted; columella plicate, the extremities of the lip united upon it by a callosity.

LEIA, Albers, 1850.

Syn.— Lia, Mörch, 1852.

Distr.—8 sp. Jamaica, Hayti. *L. Maugeri*, Wood (xcix, 57).

Shell very smooth, shining, subfusiform-cylindrical, apex truncate; eight whorls, the last contracted below, carinated at the base; aperture oblong; columella plicate; peristome not continuous, reflected. The peculiar porcellanous surface of Leia will distinguish it at once from Cylindrella.

PINERIA, Poey, 1854.

Distr.—4 sp. West Indies. *P. Viequensis*, Pfr. (xcix, 58).

Shell imperforate, conically turreted, obliquely plicate; whorls

7–8, somewhat tumid; aperture depressly rounded; peristome thin, simple, margins approximating. Jaw and radula as in Cylindrella; inferior tentacles atrophied.

MACROCERAMUS, Guilding, 1828.

Syn.—Leptospira, Swains., 1840. Colobus, Albers, 1850.

Distr.—50 sp. West Indies and adjoining Continent. *M. Jeannereti*, Gundl. (xcix, 59).

Shell oval or cylindrically turreted, apex more or less obtuse; whorls numerous, the last subangular; aperture subcircular; peristome thin; lips approaching, the columellar lip dilated and reflected.

The animal has a short foot; inferior tentacles rudimentary; jaw similar to Cylindrella, very finely plicate; radula elongated, the central tooth small, obtuse, laterals and marginals similar, palmiform, with elongated bifid internal cusps.

The shell has usually a porcellanous white surface, here and there spotted and striped with brown and ash-color.

Mr. Bland believes *Pupa vetusta*, a carboniferous fossil of Nova Scotia, to have belonged to this genus: Fischer has made for it a section of Pupa, which he calls Dendropupa.

FAMILY PUPIDÆ.

Shell generally minute, multispiral, cylindrical, with obtuse summit (Pupiform); aperture small, usually contracted by internal teeth or lamellæ.

Jaw smooth or finely striated, sometimes with a superior appendage resembling that of Succinea; radula resembling Helix, the central and lateral teeth similar, tricuspid, the marginals transverse, very short and denticulated.

PUPA, Lam, 1801.

Syn.—Cochlodonta, Fer., 1820. Cochlodon, Lowe.

Distr.—377 sp. Universal, boreal and tropical. Fossil, 50 sp. Carb., N. America; Eocene—, Europe.

Usually very small, cylindrical or oval-oblong; umbilicus slight or a mere slit; plicate, striate or costellate, brown or horn-color; columella plicate or subdentate; lip reflected, usually dentate or plicate within, the extremities usually joined by a raised callus.

Animal with a short foot, pointed behind; lower tentacles short.

ANOSTOMELLA, Martens, 1867. Shell small, short egg-shaped, ribbed, epidermis brown; lip expanded, without teeth. *P. ascendens*, Martens. Amboina.

TORQUILLA, Stud., 1820. (Chondrus, Hartmann, 1821. Granaria, Held, 1837. Alloglossa, Lindström.) Shell oval-oblong or

fusiform, turriculated, the apex somewhat sharp; aperture oval-oblong, multiplicate, sometimes edentulate; peristome expanded or reflected. *P. polyodon*, Drap. (c, 1, 2). 62 sp. Europe, N. Africa.

ABIDA, Pfr., 1878. *P. variabilis*, Drap. According to Lindström, the dentition of *P. avenacea*, Brug., resembles that of the Auriculidæ.

TOMIGERELLA, Pfr., 1878. *P. soluta*, Pfr.

MODICELLA, H. and A. Adams, 1855. Shell oblong-fusiform, striate or smooth; spire elevated conic; whorls slightly convex; aperture semi-oval, without teeth; peristome simple, or with a callous tubercle near the outer lip. *P. Farinesi*, Desm. (c, 3, 4).

CHARADROBIA, Albers, 1852. (Leiostyla, Lowe, 1852. Mastula, Lowe, 1852. Rheinhardtia, Böttger.) Shell narrowly umbilicated, elongated or cylindrical; aperture with many plicæ, transverse; peristome thin. *P. recta*, Lowe. 17 sp. Madeira, Azores, one European species (*P. anglica*, Fer.).

CRATICULA, Lowe, 1854. (Charadrobia [pars], Albers.) *P. ferraria*, Lowe. 4 sp. Madeira.

ORCULA, Held, 1837. (Eruca, Swains [pt.], 1840. Gibbulina, Drouet [pt.], 1855.) Shell oval-cylindrical; aperture semioval; columella more or less plicate, columellar lip unilamellose, peristome thin or slightly thickened, reflected. *P. doliolum*, Brug. (c, 5). 10 sp. Southern Europe.

SCARABELLA, Lowe, 1854. (Eryma, Albers, 1854. Odontocyclas, H. and A. Adams [pt.], 1855.) Shell subperforate, ovate, rather solid, costulate, variegated with chestnut; whorls eight, the last subcompressed at the base; aperture triangularly oval, with two parietal plicæ, two on the columella, and three on the outer lip; peristome slightly expanded. *P. cassida*, Lowe. 3 sp. Madeira.

ODONTOCYCLAS, Schlütter, 1838. (Scopelophila, Albers, 1850. Eryma, Albers, 1850.) Shell subperforate or rimate, conical or oval, striated; spire conic, summit obtuse; whorls slightly convex, the last compressed at the base, sometimes ascending; aperture triangularly rounded, many-toothed; peristome simple, a little expanded. *P. Rossmassleri*, Schmidt. *P. Kokeilii*, Rossmassler. 3 sp. So. Eastern Europe, Himalaya Mts.

PAGODELLA, H. Ad., 1867. Shell rimate, ovate, opaque; whorls convex; aperture semioval, with two parietal plicæ, and a thin, nearly direct peristome, the margins of which are callously connected. *P. ventricosa*, H. Ad. 2 sp. Mauritius, Isle of Bourbon.

INFUNDIBULARIA, Pfr., 1876. *P. infundibuliformis*, Orb. Bolivia.

ALVEARELLA, Lowe, 1853. Shell oval, smooth or striated; spire convex, apex obtuse; whorls convex, the last contracted at

the base; aperture subtriangular, oblong, toothed; peristome callous, reflected. *P. Sturmi*, Küster. 4 sp. Natolia, Madeira.

LEUCOCHILA, Martens, 1860. Cylindrically ovate, apex somewhat obtuse, smooth, pellucid, shining; aperture semioval, edentulous, or armed with teeth or plications; lip thickened, reflexed, rimate. *P. fallax*, Say. *P. armifera*, Say (c, 6). 8 sp. United States, West Indies.

SPHYRADIUM, Agassiz, 1837. Shell rimate or umbilicate, oblong, obconic, apex obtuse, pallid corneous, costulate; whorls 6–8, rather flat, the last compressed; aperture edentulous or few-plicate; outer lip incurved in the middle. *P. truncatella*, Pfr. 10 sp. Southern Europe, Caucasus, Himalaya Mts.

PAGODINA, Stabile, 1864. (Pagodulina, Clessin.) *P. pagodula*, Desm. Europe.

PUPISOMA, Stoliczka. Shell subconic or ovate, thin, corneous, the cuticle transversely striate; aperture edentulous; columellar lip somewhat expanded, internally twisted, often with a small tooth. 2 sp. *P. lignicola*, Stol. Penang.

DENDROPUPA, Fischer, 1883. *P. vetusta*, Dawson. Carboniferous; Nova Scotia. There are a number of tertiary species.

ANTHRACOPUPA, Whitfield, 1881. *P. Ohioensis*, Whitfield. Carb.; Ohio.

LAURIA, Gray, 1840. (Gastrodon, Lowe, 1854.) Peristome margined, reflexed; the young shell with a transverse series of short, triangular plaits, disappearing in the later whorls. *P. umbilicata*, Drap. 4 sp. Europe, Madeira, Teneriffe, Abyssinia.

PUPILLA, Leach, 1820. (Torquatella, Held, 1837. Paludinella, Lowe, 1854. Odostomia, Moquin-Tandon, 1855.) Cylindrical, apex obtuse; whorls 5–9, corneous, somewhat shining; aperture rounded, lip expanded, scarcely reflected, armed with teeth or without teeth. *P. biplicata*, Mich. (c, 7, 8). 77 sp. Universal, mostly European, Indian and North American.

VERTIGO, Müller, 1774.

Syn.—Pupella, Swains., 1840. Mastula and Staurodon, Lowe, 1852.

Distr.—100 sp. Universal. Fossil. Liassic? Miocene—.

Shell minute, rimate, oval, frequently sinistral, apex obtuse; whorls five or six, striate or plicate; aperture irregular, multidentate; peristome expanded, with white lip.

Animal without inferior tentacles; jaw nearly smooth or longitudinally wrinkled, subrostrate in the middle; marginal teeth saw-like.

ALÆA, Jeffreys, 1830. (Isthmia, Moquin-Tandon, 1855. Dexiogyra, Stabile, 1864.) Shell cylindrical; aperture denticulate or multilamellate; peristome simple. *V. antivertigo*, Drap. (c, 11,

12). 85 sp. Europe, N. Africa, East and West Indies, Polynesia, United States.

VERTILLA, Moquin-Tandon, 1855. *V. pusilla*, Müll. (c, 13). 15 sp. Europe, Australia, Sandwich Isles, etc.

ISTHMIA, Gray, 1821. (Truncatellina and Paludellina, Lowe, 1852. Edentulina, Clessin.) Shell cylindrical, summit obtuse, striated, whorls flattened; aperture semioval, edentulous; lip thin, slightly reflected. *P. columella*, Mart. (c, 9, 10). 27 sp. Europe, Africa, etc.

FAULA, H. and A. Adams, 1855. (Fauxulus, Schauf., 1869.) Shell sinistral, oval-conic, smooth; spire conical or subcylindrical, apex pointed; whorls flattened, the last narrowed towards the base; aperture semioval, plicate within the outer and on the parietal wall; peristome simple. *P. Capensis*, Kurr. (c, 100). 3 sp. Cape of Good Hope.

ZOSPEUM, Bourg., 1856.

Distr.—10 sp. Caverns in Carniola and Spain. *Z. spelæum*, Rossm. (c, 14).

Shell minute, subhyaline, pupiform, umbilicated, spire obtuse; aperture usually with columellar and parietal plicæ, sometimes edentulous.

The members of this group are met with in caverns and other places from whence the light is excluded. Bourguignat, in consequence, supposes that they are without the usual organs of vision; four tentacles. The position of this genus is somewhat doubtful; some conchologists are inclined to place it near Carychium, which its radula resembles.

STROPHIA, Albers, 1850.

Syn.—Cerion, Mörch, 1852.

Distr.—35 sp. West Indies, Florida, Bahamas. *S. uva*, Linn. (c, 15). *S. chrysalis*, Fer. (c, 16).

Shell large, pupiform, or cylindrical, with obtuse apex; striate or costate, rimate; aperture oval, with plicate columella and expanded lip.

Inferior tentacles very short; jaw finely striated with a median projection; dentition resembling Helix.

MEGASPIRA, Lea, 1834.

Syn.—Pyrgelix, Beck, 1837.

Distr.—2 sp. Forests of Brazil. Fossil, Eocene of Paris basin. *M. elatior*, Spix (c, 17).

Shell elongated, attenuated to an obtuse apex, multispiral; whorls about twenty-five in number, flattened, slowly increasing, costulate; aperture small, rounded, angular behind; columella with transverse dentiform plications; peristome simple.

CŒLIAXIS, Adams and Angas, 1855.

Distr.—2 sp. Cape of Good Hope, Solomon's Is. *C. exigua*, Ads. and Angas (c, 18).

Shell dextral, umbilicated, turreted, obliquely costulate; spire usually decollate; whorls numerous; aperture with a parietal plica or tubercle, a subcolumellar plication, and a columellar lamella not visible from without; peristome simple, continuous.

PERRIERIA, Tapparone-Canefri, 1879.

Distr.—*P. Clausiliæformis*, Tapparone. New Guinea.

Shell sinistral, many-whorled, truncated at the apex; aperture elliptical; peristome continuous; columella twisted, dentately truncate below.

Approaches Clausilia, but differs by its truncated spire and columella and want of plications.

RILLYA, Munier-Chalmas, 1883.

Distr.—Eocene; Paris. Type, *Pupa Rillyensis*, Desh.

Shell sinistral, fusiform, ventricose, apex not decollated, sharp; aperture simple or dentate; subcolumellar plication joining a columellar lamella largely developed in the interior, peristome reflected.

CLAUSILIA, Draparnaud, 1805.

Etym.—Diminutive of *clausum*, a closed place.

Syn.—Cochlodina, Fer., 1819.

Distr.—700 species and varieties. Europe (mostly southern and southeastern), Asia (mostly southern and western), Africa, West Indies (1 sp.), South America. Fossil, 20 sp. Carb.; Nova Scotia. Eocene—; Gt. Britain, France. *C. maxima*, Grat., miocene of Dax, is 2 inches long.

Shell fusiform, usually sinistral; aperture elliptical or pyriform, with a posterior sinus, contracted by lamellæ, and closed when adult by a movable shelly plate (clausilium) in the neck; peristome continuous, reflected.

Animal with a short, obtuse foot; upper tentacles short, lower very small; respiratory and genital orifices on the left side; jaw with finely sillonated surface; radula like Helix. *C. bidens* has 120 rows of 50 teeth; *C. nigricans*, 90 rows of 40 teeth each.

A peculiar and characteristic feature of the present genus is that the animal is provided with an internal process called the "*clausilium*" (iii, 42), which acts as a valve or spring-door in closing the shell against all intruders, and has been first well described by Mr. J. S. Miller, in the "Annals of Philosophy" for 1822 (vol. iii, p. 378), in the following words:—

"Independently of the various contrivances which nature has resorted to for the protection of the otherwise vulnerable mollusca, it has taken peculiar care to guard the apertures of many

univalves from the intrusion of enemies; hence the apertures are sometimes contracted and provided with numerous folds and teeth. Other mollusca have a calcareous operculum permanently formed, which increases in thickness, and enlarges on a depressed spiral plane, as the opening of the shell extends with the growth of the animal, thus continually assimilating to its size, and when the animal retreats, excluding it completely from all external intrusion. In the Clausilia nature has continued the protection afforded by means of contractions and folds, and also added an opercular appendage. The inhabitant of the Clausilia, when nearly full-grown, secretes a thread-like elastic calcareous filament, one of whose ends is affixed to the columella. This filament makes half a spiral turn round the columella, insinuating between its folds. When the animal finishes its shell and completes the aperture, it secretes, at the unattached end of the filament, a spoon-shaped calcareous lamina conforming at its margin to the contour of the aperture. The lamina is somewhat smaller than this, and its margin is rounded. Its adhesion to an elastic filament enables the animal to push it, when it comes out of the shell, against the columella; and the same elasticity closes it on the inhabitant retreating, thus securing it from intruding enemies. Thus, then, this valve may be compared to a door provided with an elastic spring. The elasticity of the filament may be restored to its full power (in the empty shell) by sometimes immersing it in water, as I have ascertained in a section made with a view to this inquiry."

The following arrangement of the subgenera or sections of Clausilia is essentially that of O. Böttger, who has devoted much time and attention to the study of the systematic relationship of the species.

BALEA, Prid., 1824. (Baleastra, Pfr., 1855. Tristania, Böttg., 1878. Pseudobalea, Shuttl., 1854.) Shell thin, spiral, turriculated, sinistral; aperture rounded in front, angular behind, without lunule; columella simple or uniplicate; no clausilium. *C. Tristensis*, Leach, and *C. perversa*, L. (c, 20). Europe, Tristan d'Acunha, New Zealand. The want of posterior lunule or bay of the aperture and of a clausilium, makes this an aberrant form, and it has sometimes been considered a distinct genus; it is united to the typical Clausilia, however, through the group Alopia, Adams, in which the clausilium is sometimes absent, sometimes more or less developed.

TEMESA, H. and A. Adams, 1855. Columella plicate at the base. *B. Clausilioides*, Reeve (c, 19). Peru.

DACTYLIUS, Sandberger, 1870. (Filholia, Bourg., 1877.) Shell very large, with pear-shaped aperture, continuous peristome, and columella with a basal lamella. *Bulimus lævolongus*, Boubée. Fossil. Lower Tertiary; Europe.

REINIA, Kobelt. *C. variegata*, A. Adams. Japan. Shell bulimiform.

TRIPTYCHIA, Sandb. (Milne-Edwardsia, Bourg.) Shell large, subfusiform; columellar lamella and plication subparallel, continuous for a number of whorls; parietal lamella more or less developed; the other plicæ of Clausilia are absent. Clausilium? *C. antiqua*, Schubl. Only fossil species, miocene, and a few pliocene.

ALOPIA, H. and A. Ad., 1855. (Attica, Böttger, 1877.) Shell dextral, thin, livid, more or less plicate, without lunule; internal plicæ numerous; spiral lamella disjoined; last whorl rounded at the base; peristome continuous. *C. Guicciardi*, Held, and *C. livida*, Mke. Attica and Transylvania.

EUALOPIA, Böttger, 1877. Only fossil species, miocene. *C. bulimoides*, A. Braun.

TRILOBA, Vest, 1867. (Macedonica, Böttg., 1877.) *C. Sandrii*, Kust., and *C. Macedonica*, Rossm. (c, 21, 22). Montenegro and Macedonia.

MARPESSA, Moq.-Tand. (emend.), 1855. (Dyodonta, Hartmann, 1844.) Shell usually smooth, shining, corneous, the last whorl slightly compressed; aperture rounded at the base; four parietal plications usually; no lunule. *C. transiens*, Mollend., and *C. laminata*, Mont. Europe.

HERILLA, H. and A. Adams (emend.), 1855. (Turcica, Böttg., 1877.) Smooth, shining, corneous, generally thin; lunule more or less perfect; spiral lamella disjoined; inferior internal plications visible. *C. Frivaldskiana*, Rossm., and *C. Dacica*, Friv. European Turkey, Servia and Dalmatia.

SICILIARIA, Vest, 1867. (Trinacria, Böttg., 1877.) *C. septemplicata*, Phil. (c, 23), and *C. crassicostata*, Ben. Sicily.

DELIMA, Hartm., 1844, (emend.). (Subsections: Gibbula, Stigmatica, Piceata, Itala, Tirolica, Dalmatica, Binodata, Lævissima, Albanica, Montenegrina, Substricta, Robusta, Semirugata, all of Böttger, 1877.) Corneous, shining, more or less pellucid; plication external; spiral lamella disjoined. *C. gibbula*, Ziegl. *C. stigmatica*, Ziegl. *C. piceata*, Ziegl. *C. Itala*, Mart. *C. Stentzi*, Rossm. *C. conspurcata*, Jan. *C. binodata*, Ziegl. *C. lævissima*, Ziegl. *C. Cattaroensis*, Ziegl. *C. substricta*, Parr. *C. robusta*, Küst., and *C. semirugata*, Küst. Dalmatia, southeastern parts of the Alps, Italy.

MEDORA, H. and A. Ad., 1855 (emend.). Whitish or bluish; lunule more or less perfect; peristome continuous, free, sometimes advanced. *C. macarana*, Ziegl. Dalmatia, Carniolia, Calabria.

AGATHYLLA, H. and A. Ad., 1855 (emend.). Grayish, costulate; lunule none or imperfect; spiral lamella disjoined; one to three internal plications. *C. exarata*, Ziegl. (c, 24). Dalmatia, Bosnia.

CONSTRICTA, Böttg., 1877. *C. tenuisculpta*, Reuss. All miocene species.

CRISTATARIA, Vest, 1867. *C. strangulata*, Fer. Syria, Palestine, Crete, Macedonia.

ALBINARIA, Vest, 1867. (Subsections: Filumna, Cretica, Striata, Egana, Sericata, Profuga, Lampedusa, Bigibbosa, Archipelagica, Mirabellina, Corrugata, Interstriata, Teres, Munda, Scopulosa, Laconica, Cerigana, Graja, Nævosa, all of Böttger, 1878.) *C. cærulea*, Fer. Greece and its islands, Asia Minor.

CARINIGERA, Möllend., 1873. Neck provided with a keel, which runs parallel to the lamella. *C. eximia*, Möllend. Servia.

PAPILLIFERA, Hartm., 1844 (emend.). (Papillina, Moquin-Tandon, 1855. Subsections: Isabellaria, Vest, 1867. Venusta, Böttger, 1877. Euclista, Böttger, 1878.) Corneous; lunule perfect; no internal plications nor spiral lamella. *C. lampedusæ*, Calc. *C. Isabellina*, Pfr. *C. venusta*, A. Schm. *C. Græca*, Pfr. *C. leucostygma*, Ziegl. *C. saxicola*, Parr. *C. solida*, Drap., and *C. bidens*, L. (c, 25, 26). Italy and Greece.

DILATARIA, Vest, 1867. (Subsections: Banatica, Böttg., 1877. Charpentieria, Stabile, 1864.) *C. tenuilabris*, Rossm. *C. succineata*, Ziegl., and *C. diodon*, Stud. Austrian provinces and Piedmont.

PHÆDUSA, H. and A. Ad., 1855. (Subsections: Euphædusa, Pseudonenia, Stereophædusa, Formosana, Megalophædusa, Oospira, Acrophædusa, Cylindrophædusa, Hemiphædusa, all of Böttger, 1877.) Shell smooth, more or less solid, yellowish or corneous; lunule obsolete or none; spiral lamella generally disjoined; last whorl rounded at the base; peristome continuous, free. *C. Shanghaiensis*, Pfr. *C. valida*, Pfr. *C. Yokohamensis*, Crosse. *C. Swinhoei*, Pfr. *C. Philippiana*, Pfr. *C. cornea*, Phil. *C. cylindrica*, Gray. *C. Cochinensis*, Pfr. (c, 27). *C. pluviatilis*, Bens. Eastern Asia.

SERRULINA, Mouss., 1873. (Subsection: Filosa, Böttger, 1877.) *C. serrulata*, Midd. *C. filosa*, Mouss. Transcaucasia.

FUSULUS, Vest, 1867. *C interrupta*, Ziegl. *C. varians*, Zieg. S. E. Germany.

PSEUDALINDA, Böttger, 1877. (Subsection: Mira, Böttg., 1877.) *C. fallax*, Rossm. (c, 28, 29). *C. mirabilis*, Parr. Transylvania and Asia Minor.

UNCINARIA, Vest, 1867. *C. turgida*, Zieg. Transylvania and Bukowina.

MENTISSOIDEA, Böttger, 1877. *C. fusorium*, Mouss. Transylvania

MENTISSA, H. and A. Ad., 1855 (emend.). (Subsections: Index, Polyptychia, Galeata, Strumosa, Mucronaria, Acroeuxina, Quadriplicata, Megaleuxina, Caucasica, Laciniaria, all of Böttger,

1877.) More or less smooth, corneous; lunule obsolete; last whorl with a basal crest. *C. gracilicosta*, Ziegl. Crimea.

EMARGINARIA, Böttger, 1877. *C. Schæfferiana*, Böttger. Miocene.

CANALICIA, Böttg., 1863. *C. articulata*, Sandb. All species miocene.

EUXINA, Böttger, 1877. *C. Duboisi*, Charp. *C. Schwerzenbachi*, Parr. *C. strumosa*, Friv. *C. acuminata*, Mouss. *C. hetæra*, Friv. *C. Huebneri*, Rossm. *C. Sandbergeri*, Mouss. *C. Somchetica*, Pfr. *C. mæsta*, Fer. Crimea, Transcaucasia, Asia Minor, Syria.

ALINDA, H. and A. Ad., 1855 (emend.). (Iphigenia, Gray, 1840.) Lunule perfect; spiral lamella disjoined; internal plications numerous; last whorl compressed; aperture canaliculate at the base. *C. biplicata*, Mont. *C. plicata*, Drap. *C. index*, Mouss. Transcaucasia.

STRIGILLARIA, Vest, 1867. *C. cana*, Held. Germany and S. E. Europe.

PSEUDIDYLA, Böttger, 1877. *C. Maersingensis*, Sandb. Only two miocene species.

IDYLA, H. and A. Ad., 1855 (emend.). (Subsections: Bitorquata, Bulgarica, Böttger, 1877.) Lunule distinct; plications few or obsolete; last whorl presenting at the base a large single or double crest; aperture more or less canaliculated. *C. pagana*, Ziegl. *C. bitorquata*, Friv. *C. Varnensis*, Pfr. S. E. Europe and Syria.

OLIGOPTYCHIA, Böttger, 1877. (Crucita, Westerlund, 1878. Subsections: Armenica, Scrobifera, Hellenica, Böttger, 1877.) *C. lævicollis*, Parr. *C. foveicollis*, Parr. *C. Pikermiana*, Roth. Greece, Transcaucasia, Asia Minor and Syria.

PIROSTOMA, Vest, 1867 (emend.). (Plicaphora, Hartmann, 1844. Macrogastra, Strobel, 1850. Elia, H. and A. Adams, 1855, part. Subsections: Erjavecia, Brusina, 1870 [Trigonostoma, Vest, 1867]. Kuzmicia, Brus., 1870 [Iphigenia, Westerlund, 1878]. Graciliaria, Bielz., 1867.) *C. Bergeri*, Meyer. *C. rugosa*, Drap. *C. plicatula*, Drap. *C. ventricosa*, Drap. (c, 30). Europe.

LAMINIFERA, Böttg., 1863. (Tortula, West.) *C. Pauli*, Mabille. *C. rhombostoma*, Böttg. Pyrenees. Miocene and one oligocene species.

NENIA, H. and A. Ad., 1855. Costellate or striate; no lunule; plication simple, superior; spiral lamella continuous; last whorl rounded at the base, produced; aperture in the axis of the shell; peristome continuous, reflected. *C. Blandiana*, Pfr. *C. cyclostoma*, Pfr. *C. tridens*, Chem. (c, 31). *C. Bartletti*, H. Ad. *C. perarata*, Martens. *C. Bourcieri*, Pfr. New Grenada, Ecuador, Peru and Porto Rico.

NENIATLANTA, Bourg. Peristome feeble; under lamella parallel to the upper. 2 sp. Pyrenees.

DISJUNCTARIA, Böttger. *C. oligogyra*, Böttger. Eocene.

MACROPTYCHIA, Böttger. *C. Sennaariensis*, Pfr. N. E. Africa.

BOETTGERIA, Heynem., 1861. *C. crispa*, Lowe, and *C. deltostoma*, Lowe. Madeira.

OLYMPIA, Vest, 1867. *C. Olympica*, Friv. Mt. Olympus.

FAMILY LIMACIDÆ.

Shell rudimentary, a calcareous plate, not spiral, concealed under the mantle, and covering the respiratory cavity. Foot with or without mucous pore; jaw oxygnathous, arcuated, without ribs, with a rostriform projection on the inferior margin (xiii, 62); lingual plate with tricuspidate central tooth, the middle cusp long and narrow, laterals bi- or tricuspidate, marginals narrow, sharp uni- or bicuspidate (xiii, 61). The slugs are often crepuscular in their habits and are chiefly herbivorous, although sometimes taking decaying animal substances. They inhabit woods and gardens, coming forth after showers or when the dew is on the ground. In the United States several species are commonly found in the cellars of houses. Some of the limaces occasionally climb small trees or bushes and suspend themselves from the branches or leaves by a glutinous thread.

For the generic descriptions of the slugs of this and the following families I am indebted to Mr. William G. Binney, of Burlington, N. J., to whom I am also under many obligations for advice upon the treatment of some of the shell-bearing pulmonates.

LIMAX, Linn., 1758.

Distr.—100 sp. Universally distributed. *L. alpinus*, Fer. (ci, 56). *L. Lartetii*, Dupuy (ci, 57).

Animal attached its whole length to the foot, subcylindrical, tapering behind, bluntly truncate anteriorly; tentacles simple; mantle small, anterior, enclosing a shelly plate; no longitudinal furrows above the margin of the foot, nor caudal mucous pore; a distinct locomotive disk; external anal and respiratory orifices at the right posterior margin of the mantle; orifice of combined generative organs behind and below the right peduncle.

Shell-plate testaceous, thin, flat, longer than wide, with concentric striæ of increase, internal.

Jaw smooth, with median projection. Lingual membrane long and narrow; central teeth tricuspid, laterals bicuspid, marginals aculeate, often bifid. Considerable variation is found in the dentition of the genus; the centrals and laterals are sometimes unicuspid.

The following generic and subgeneric names have been sug-

gested for species of Limax, founded mostly on the peculiarities of the mantle, genitalia and lingual dentition: Eulimax, Agriolimax, Milax (Gray), Amalia, Lehmannia, Limacus (Lehmann), Krynickellus, Krynickia, Heynemannia, Plecticolimax, Hydrolimax, Lallemannia (Mabille), Malino (Gray), Malinastrum, Gestroa, Chromolimax, Opilolimax, Stabilea, Malicolimax, Megapelta (Mörch), Clytropelta, Ibycus.

AMALIA, Moquin-Tandon, 1855. (Milax, Gray, 1855.) Mantle more or less rugose, no concentric striæ; tail strongly carinated; shell-plate with median nucleus. *L. Sowerbyi*, Fer.

EULIMAX, Moquin-Tandon. Mantle with more or less distinct concentric striæ, no rugosities. *L. alpinus*, Fer. (ci, 56). *L. gagates*, Drap. (ci, 58).

MALINO, Gray. Back keeled; dorsal shield large, front half concentrically, hinder longitudinally furrowed, very contractile, very mobile, moving rapidly from side to side as the animal walks. *M. lumbricoides*, Morelet.

KRYNICKIA, Kalenicz. Shield very large, only adhering behind; body slender; respiratory orifice on the right posterior margin of the mantle. *L. brunneus*, Drap. Megapelta, Mörch, a Central American group, is very similar. *L. semitectus*, Mörch.

PARMACELLA, Cuv., 1805.

Syn.—Girasia, Drusia, Gray (part).

Distr.—Around Mediterranean, Canaries, Central Asia. *P. Valenciennesi*, Webb (c, 41).

Animal limaciform, subcylindrical, swollen behind, gradually attenuated before; tentacles simple; mantle large, central, concealing the shell; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; distinct locomotive disk? external respiratory and anal orifices at the right posterior margin of the mantle; orifice of the combined generative organs behind and below the right eye-peduncle.

Shell small, testaceous, internal, rudimentary, subspiral, aperture very large, dilated anteriorly.

Jaw smooth, with a median projection. Lingual membrane with tricuspid centrals, first laterals tricuspid also, marginals aculeate.

The young animal is entirely enclosed in the shell, which is furnished with a sort of operculum. As the animal grows the operculum falls, the shell becomes covered with the mantle, and only increases at its outer margin, like the simple shell-plate of Limax.

CRYPTELLA, Webb and Bertholet, 1833. Canary Islands. Shell less distinctly spiral.

During eight or nine months in the year their vital activity is suspended, and they remain concealed under the large blocks of

lava with which these islands are covered; they are herbivorous, and during the rainy season, especially in the night, they quit their retreats and commit great havoc in the gardens. The peasants destroy them by thousands, but, notwithstanding this persecution, their numbers do not appear to diminish.

PHOSPHORAX, Webb and Bertholet, 1838.

Distr.—*P. noctilucens*, W. and B. (ci, 61). Teneriffe.

Animal limaciform, swollen at middle; tentacles simple; mantle large, anterior, with a posterior, small, phosphorescent disk, and concealing a shell-plate; no longitudinal furrows above the margin of foot and no caudal mucous pore shown in the plate; distinct locomotive disk? external anal and respiratory orifices on right anterior margin of mantle; generative orifice? Internal shell-plate thick, oval, testaceous. Jaw? Lingual membrane? Teneriffe. A doubtful genus, so little do we know of it. It is impossible to ascertain its systematic position.

MARIAELLA, Gray, 1855.

Syns.—Tennentia, Humbert, 1862. Clypeicella, Val.

Distr.—5 sp. Philippines, Seychelles Is. *M. Dussumieri*, Gray (xcii, 78).

Body limaciform, subcylindrical, attenuated behind; tentacles simple; mantle large, anterior, concealing the shell; longitudinal furrows above the margin of the foot, meeting over a linear caudal mucous pore; distinct locomotive disk; external respiratory and anal orifice on the right central margin of mantle; orifice of combined genital system behind and below the right eye-peduncle.

Shell internal, small, rudimentary, convex above, flat below, apex on right posterior side, recurved.

Jaw smooth, with median projection. Lingual membrane with tricuspid centrals and laterals, and aculeate, bifid marginals, in the typical species; others vary.

The swollen central portion of the animal seems the first approach to a turbinate mass of viscera, separated from the foot.

PARMARION, Fischer.

Syn.—Girasia, Gray (in part), 1855.

Distr.—10 sp. Java, India. *P. papillaris*, Humb. (ci, 58, 59).

Animal limaciform, subcylindrical, tapering behind; tentacles simple: mantle large, anterior, enclosing an internal shell-plate, which is partially exposed by a posterior opening; distinct locomotive disk? longitudinal furrows above the margin of the foot and caudal mucous pore, over which is a horn-shaped process; external, anal and respiratory orifices on the posterior right

margin of mantle (see von Martens' figure of *P. papillaris*); orifice of combined genital system?

Shell-plate internal, rudimentary, flat, with a side nucleus.

Jaw smooth, with a median projection.

Lingual membrane with tricuspid centrals, bicuspid laterals, and aculeate, bifid marginals.

UROCYCLUS, Gray, 1864.

Distr.—Mozambique, Prince's Isle, etc. *U. Kirkii*, Gray (ci, 60).

Animal limaciform, subcylindrical, blunt before, tapering behind; tentacles simple; mantle small, anterior, with a posterior opening, and concealing an internal shell-plate; longitudinal furrows above the margin of the foot and caudal mucous pore; a distinct locomotive disk; external respiratory and anal orifices on the right slightly anterior margin of the mantle; orifice of combined generative organs behind and below right eye-peduncle.

Shell-plate internal.

Jaws smooth, without median projection.

Lingual membrane with tricuspid centrals, bicuspid laterals, aculeate and bifid marginals.

Nearly allied to Parmarion; seems only to differ by the position of the respiratory orifice, and the want of the horn-shaped process to the caudal pore.

DENDROLIMAX, Heynem., 1868.

Distr.—Prince's Island. *D. Heynemanni*, Dohrn.

Animal limaciform, subcylindrical, blunt before, tapering behind, tentacles simple; mantle small, anterior, concealing an internal shell-plate, perforated posteriorly; longitudinal furrows above the margin of the foot? a caudal mucous pore, with overhanging, horn-shaped process; distinct locomotive disk; anal and respiratory orifices at anterior right edge of mantle; orifice of combined genital system behind and below right eye-peduncle.

Shell-plate internal, suboval, slightly convex, small, with posterior nucleus and concentric lines of growth.

Jaw smooth, with median projection.

Lingual membrane with peculiarly shaped teeth, centrals tricuspid, laterals bicuspid, marginals aculeate, bicuspid.

The horn-shaped process only seems to distinguish it from Urocyclus, the position of the respiratory orifice from Parmarion.

Dentition peculiar.

Dr. Fischer considers this genus a synonym of Urocyclus, Gray.

OOPELTA, Mörch, 1867.

Distr.—Java, Ceylon, Cape of Good Hope, Guinea. *O. nigropunctata*, Mörch.

Body limaciform, subcylindrical, tapering behind; tentacles simple; mantle small, oval, more pointed behind; no longitudinal furrows above the margins of the foot, and no caudal mucous pore; no distinct locomotive disk; external respiratory and anal orifices on the right slightly anterior margin of the mantle; orifice of combined generative system behind and under the right eye-peduncle.

No internal shell-plate.

Jaw smooth, with a median projection.

Lingual membrane with tricuspid centrals, bicuspid laterals, quadrate marginals.

The two following genera, together with Selenites, Fischer (*Helix concava*, Say), constitute the family Selenitidæ, Fischer, characterized by the dentition of Testacella united to the jaw of Limax. The elements thus united appear to me to be otherwise too incongruous. If such characters are sufficient for the formation of families, then Cystopelta, Tate, would require a new family also, having the teeth of Testacellidæ with the ribbed jaw of Arion; and so we might multiply families *ad infinitum.*

PLUTONIA, Stabile, 1864.

Syn.—Viquesnelia, Morelet (not Deshayes).

Dist.—*P. Atlantica*, Morelet. Azores.

Body compressed behind, carinated, rugose; mantle median, free in front, with posterior pulmonary orifice; posterior extremity subtruncated, without mucous pore; jaw without ribs or median rostriform projection; teeth like Testacella. Internal shell-plate oblong, Ancyliform, with a rudimentary spire.

The shell of this genus was considered by Morelet and Drouet a recent representative of the genus Viquesnelia, Desh., 1857; a name given to certain fossils of the nummulitic beds of Roumelia. The identification is, however, imaginary.

TRIGONOCHLAMYS, Böttger, 1881.

Dist.—*T. imitatrix*, Böttg. Caucasus.

Animal limaciform, with two dorsal and two lateral grooves, directed from the mantle towards the head; mantle behind the middle of the body very small, attached all around, granular; anal and respiratory orifices behind the right margin of the mantle; tail short, compressed, carinated, without mucous pore; jaw similar to that of Parmacella, radula to Testacella. No internal shell ?

PSEUDOMILAX, Böttger, 1881. Differs in its mantle, being free in front and on the right side; genital orifice on the right side of the neck. Jaw and radula not observed. No internal shell? *P. Lederi*, Böttger. Caucasus.

ASPIDIPORUS, Fitzinger, 1833.

Like Limax, with perforated mantle.

FAMILY TEBENNOPHORIDÆ.

Animal naked. Mantle covering the entire back. No mucous pore; jaw oxygnathous; lingual dentition similar to Helix. No shell.

TEBENNOPHORUS, Binn., 1842.

Syn.—Incillaria, Bens., 1842. Megimathium, Van Hasselt, 1824. Philomycus, Raf., 1820.

Distr.—Asia, North and Central America. *T. Carolinensis*, Bosc (ci, 52; iii, 44). United States.

Animal limaciform, cylindrical, blunt before, slightly attenuated behind; tentacles simple; mantle covering the whole back; no longitudinal furrows above the margin of the foot, and no caudal pore; no distinct locomotive disk; external respiratory and anal orifices near the head, somewhat to the rear of the right eye-peduncle; orifice of combined genital system behind and below the right eye-peduncle.

Shell or shell-plate none.

Jaw smooth, with median projection.

Lingual membrane long and narrow, centrals and first laterals unicuspid, outer laterals bicuspid, marginal teeth quadrate.

PALLIFERA, Morse, 1864. Jaw ribbed. *P. dorsalis*, Binney. United States.

FAMILY ARIONIDÆ.

Animal naked, with or without mucous pore; mantle concealing a shell-plate, or a few calcareous grains which represent it; jaw strongly ribbed; central tooth tricuspidate, the median cusp long and narrow, laterals and marginals bicuspidate.

ARION, Fer.

Syn.—Prolepis and Lochea, Moquin-Tandon, 1855. Baudonia, Mabille. Kobeltia, Seibert.

Distr.—Europe, Northern Asia and Africa. *A. fuscatus*, Fer. (ci, 53).

Animal limaciform, subcylindrical, attenuated behind; tentacles simple; mantle small, anterior, concealing calcareous grains, sometimes agglomerated into a shelly plate; longitudinal furrows above the margins of the foot, meeting over a caudal

mucous pore; a distinct locomotive disk; exterior respiratory and anal orifices on the anterior right margin of the mantle; orifice of the combined genital system below the last.

Internal calcareous grains, in some species agglomerated, forming an imperfect shell-plate.

Jaw ribbed. Lingual membrane with tricuspid central teeth, tricuspid or bicuspid laterals, and quadrate marginals.

The "land-soles" occasionally devour animal substances, such as dead worms or injured individuals of their own species. They lay 70–100 eggs between May and September, are 26–40 days hatching, and attain their full growth in a year; they begin to oviposit a month or two before that period. The eggs of *A. hortensis* are very phosphorescent for the first fifteen days (Bouchard).

BAUDONIA, Mabille. Distinguished from Arion by being anteriorly enlarged and depressed, the shield almost smooth, the head well separated from the body, and the tentacles rather small. Characters of but little value. 2 Portuguese sp.

ARIUNCULUS, Lessona, 1881. Genital orifice nearer the tentacle than the pulmonary orifice. 3 sp. *A. Speziæ*, Lessona. Piedmont.

LOCHEA, Moquin-Tandon, 1855. Shell represented by unequal, isolated, calcareous granulations. *A. rufus*, Linn. Europe.

PROLEPIS, Moquin-Tandon, 1855. Shell rugose, produced by the aggregation of separate calcareous particles. *A. fuscus*, Müll. Europe.

ARIOLIMAX, Mörch, 1860.

Distr.—5 sp. Pacific coast of United States. *A. Columbianus*, Gould (ci, 54).

Animal limaciform, subcylindrical, tapering behind; tentacles simple; mantle anterior, small, concealing an internal shell-plate; longitudinal furrows above the margin of the foot, meeting over a caudal mucous pore; a distinct locomotive disk; external respiratory and anal orifices on the posterior right margin of the mantle; orifice of combined genital system on the right side of the body, below the anterior free edge of the mantle. Shell-plate internal, solid, flat, longer than wide.

Jaw ribbed. Lingual membrane with tricuspid centrals, bicuspid laterals and quadrate marginals.

Ariolimax differs from Prophysaon by the position of the respiratory orifice in the hinder half, and of the genital orifice below the free part of the shield, and the presence of a mucous pore.

GEOMALACUS, Allman, 1843.

Distr.—Eastern Europe. *G. maculatus*, Allm. (ci, 55).

Animal limaciform, subcylindrical, blunt behind; tentacles

simple; mantle anterior, close to head, concealing a shell-plate; longitudinal furrows above the margin of the foot? a caudal mucous pore; a distinct locomotive disk; external respiratory and anal orifices on the right far anterior margin of mantle; orifice of combined genital system behind and below right eye-peduncle.

Shell-plate calcareous, flat, small, internal, ovate.

Jaw ribbed. Lingual membrane with tricuspid centrals, bicuspid laterals, quadrate marginals.

LETOURNEUXIA, Bourg., 1866. Animal limaciform, subcylindrical, scarcely attenuated behind; tentacles simple; mantle small, anterior, concealing a shell-plate; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; no distinct locomotive disk; external respiratory and anal orifices on the right anterior margin of the mantle; orifice of the combined genital system? Shell-plate internal, calcareous, suboval, flat. Jaw ribbed. Lingual membrane? There is a peculiar overhanging process to the side of the body, near the tail. Algiers. *G. Numidicus*, Bourg.

ANADENUS, Heynemann, 1863.

Distr.—2 sp. Himalaya Mountains. *A. giganteus*, Heynem.

Animal limaciform, subcylindrical, tapering behind; tentacles simple; mantle anterior, concealing an interior shell-plate; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; a distinct locomotive disk; external respiratory and anal orifices on the right posterior margin of the mantle; orifice of the combined genital system behind and below the right eye-peduncle.

Internal shell small, oval, flat, with posterior nucleus and concentric striæ.

Jaw with numerous ribs. Lingual membrane with tricuspid centrals, bicuspid laterals, and quadrate marginals.

PROPHYSAON, Bland and Binney, 1873.

Distr.—1 sp. Pacific coast of United States. *P. Hemphilli*, Binney and Bland.

Animal limaciform, subcylindrical, tapering behind; tentacles simple; mantle small, anterior, concealing a shell-plate; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; no distinct locomotive disk; external respiratory and anal orifices on the right anterior margin of the mantle; orifice of combined genital system behind and below the right peduncle.

Internal shell-plate thick, small, flat, longer than wide.

Jaw ribbed.

Lingual membrane with tricuspid centrals, bicuspid laterals and quadrate marginals.

Closely allied to Anadenus.

HEMPHILLIA, Bl. and Binn., 1872.

Distr.—1 sp. *H. glandulosa*, B. and B. (xcii, 74). Coast of Oregon.

Animal limaciform, blunt before, swollen at centre, and greatly attenuated behind; tentacles simple; mantle subcentral, large, oval, concealing all but a rounded large orifice; an internal shell-plate; longitudinal furrows above the margin of the foot and caudal mucous pore, over which is a hump-like process; no distinct locomotive disk; external respiratory and anal orifices at the central right margin of the mantle; orifice of combined genital system near the right eye-peduncle.

CRYPTOSTRAKON, W. G. Binn., 1879.

Distr.—*C. Gabbi*, Binney. Costa Rica.

Animal limaciform, subcylindrical, attenuated behind; tentacles simple; mantle slightly anterior, thin, small, concealing the shell; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; distinct locomotive disk? external respiratory and anal orifices on the right central margin of the mantle; orifice of genital organs?

Shell internal, sigaretiform, rudimentary, large as mantle, membranous, subspiral, with postero-lateral nucleus.

Jaw ribbed. Lingual membrane with tricuspid central teeth, bicuspid laterals, and quadrate marginals.

CYSTOPELTA, Tate, 1881.

Distr.—*C. Petterdi*, Tate. Tasmania.

Body attached for half its length to the back of the foot; mantle very large, enveloping the whole animal in repose, but from beneath which the head and the tip of the tail alone are visible from above, when the animal is crawling; tentacles four; tail with a mucous pore at the tip; mandible like that of Arion; lingual teeth resembling those of Testacella. No shell.

DAMAYANTIA, Issel, 1874.

Distr.—*D. dilecta*, Issel. Borneo.

Animal without shell; mantle forming a rounded prominence in the front half of the body; a mucous pore at the hinder end of the foot. No jaw observed.

OTHELOSOMA, Gray.

Insufficiently described, resembling more the leech of Ceylon

than a slug. No exact generic characters are given. *O. Sysmondii*, Gray. Gaboon, Africa.

EUMELUS, DEROCERAS, ZILOTEA, URCINELLA, TESTACINA, LIMACIAS, Rafinesque. All unrecognized genera of slugs.

PARMULA, SCUTELLIGERA = Larvæ of insects —GRAY, *Cal. Brit. Mus.*, 161.

† † *Elasmognatha.*

Jaw with a superior quadangular accessory plate.

FAMILY SUCCINEIDÆ.

Shell oblique, sometimes flattened, paucispiral, very thin, transparent.

Inferior tentacles but slightly developed or wanting; jaw with a median quadrangular accessory piece, projecting upwards (xiii, 63); central tooth tricuspid, same size as the laterals which are bi- or tricuspid, marginals narrow at base, multicuspid.

SUCCINEA, Drap., 1801.

Syn.—Cochlohydra, Fer., 1819. Neritostoma, Klein, 1753. Lucena, Oken, 1815. Amphibina and Amphibulina, Hartmann, 1821.

Distr.—200 sp., world-wide; subaquatic, living in damp places, near the margins of streams. Fossil; Eocene—.

Shell oval, very fragile and transparent; spire short; the whorls few, and very rapidly enlarging; aperture oval; outer lip thin, not reflected, united below by a broad curve with the thin, smooth columella.

Animal large, usually barely retractible within its shell; tentacles short and thick, the inferior pair inconspicuous; foot broad.

TAPADA, Studer, 1830. (Succinea, restricted.) Whorls well-rounded, with impressed sutures. *S. obliqua*, Say (c, 32). U. S.

BRACHYSPIRA, Pfr., 1855. Shell ovate, inflated; spire very short, acuminate; last whorl flattened, scutiform; aperture large, angulated. *S. ovalis*, Gould. *S. putris*, Linn. (c, 33).

TRUELLA, Pease, 1871. Shell elongate, slender; aperture contracted behind. 3 sp. Polynesia. *S. procera*, Gld., etc.

PELTA, Beck, 1837. *S. Cumingii*, Beck. Ins. Juan Fernandez.

HELISIGA, Lesson, 1829. Shell ovate-ventricose; spire very short; aperture wide, patulous; peristome acute. Eye-peduncles short, cylindrical, swollen at the base; tentacles short, rudimentary. *S. Sancta-Helenæ*, Lesson. St. Helena.

OMALONYX, d'Orb., 1841.

Distr.—5 sp. West Indies and Brazil. *O. unguis*, d'Orb. (c, 36).

Animal limaciform, blunt before, short behind; tentacles simple; mantle large, central, its margins holding the edges of the external shell; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; no distinct locomotive disk; external respiratory and anal orifices on the right central margin of the mantle; generative orifice below and behind the right eye-peduncle.

Shell external, its margins embedded in the mantle, rudimentary, paucispiral, oval, depressed, unguiform.

Jaw smooth, with median and accessory quadrate plate. Lingual membrane with tricuspid centrals, tricuspid laterals, and multifid quadrate marginals.

Hyalimax, H. and A. Ad., 1855.

Distr.—Mauritius, Nicobar Islands. *H. pellucidus*, Quoy (ci, 49, 50).

Animal limaciform, swollen at centre, blunt before, and tapering behind; tentacles simple; mantle large, central, concealing all but a small opening; an internal shell-plate; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; no distinct locomotive disk; external respiratory and anal orifices on the central right margin of the mantle; orifice of combined genital system on right side of head, halfway between eye-peduncle and mantle.

Shell large, rudimentary, thin, oval, unguiform, non-spiral.

Jaw smooth with blunt median projection and accessory quadrate plate.

Lingual membrane with tricuspid central teeth, multifid laterals, and quadrate marginals.

Lithotis, Blanford, 1863.

Distr.—3 sp. India, Tahiti. *L. rupicola*, Bl. (c, 40).

Shell external, auricular, ovate, thin, with an external longitudinal carina and corresponding internal sulcus; aperture rather large, continuous; spire small. The animal has large eyes, on short, retractile peduncles tumid towards the base; inferior tentacles not visible; foot short, pyriform.

Jaw oxygnathous; radula like Helix.

The position of this genus is uncertain; it appears to agree with the Succineidæ in the want of inferior tentacles, but differs in the character of the jaw.

Catinella, Pease, 1871.

Distr.—3 sp. Polynesia. *C. rubida*, Pease. *C. explanata*, Gld. (c, 34).

Shell planulate, fragile, spire rudimentary. Arboreal.

ATHORACOPHORUS, Gould.

Syn.—Janella, Gray. Aneitea, Gray. Aneiteum, McDon. Triboniophorus, Hubert.

Distr.—New Hebrides, etc. *A. bitentaculata*, Gray (ci, 51).

Animal limaciform, subcylindrical, tapering behind; inferior tentacles wanting; mantle anterior, small, triangular, lateral, adherent, enclosing the shell-plate; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; no distinct locomotive disk; external respiratory and anal orifices on the right central margin of the mantle; orifice of the combined genital system behind and below the right eye-peduncle.

Shell-plate internal, flat, calcareous, oblong, sometimes in separate grains.

Jaw smooth, with median projection and quadrate accessory plate.

Lingual membrane with peculiarly shaped teeth, with long, narrow, curving, base of attachment, and low, transverse, multifid cusp.

The animal has peculiar dorsal grooves.

CONOPHERA, Hutton. Eye-peduncles short and conical. *C. marmorea*, Hutton. New Zealand.

SUBORDER *DITREMATA*.

Male and female orifices widely separated; oculiferous tentacles simply contractile, not invertible.

FAMILY VERONICELLIDÆ.

Characters those of the genus Veronicella. The Veronicellidæ are terrestrial, the Oncidiidæ, aquatic animals.

VERONICELLA, Blain (emend.), 1817.

Syn.—Vaginula, Fer., not Vaginulus, Stoliczka.

Distr.—Asia, Africa, South and North America, in warm latitudes. *V. Floridana*, Binney (cii, 66, 67).

Animal limaciform, elongate-ovate, rounded above, flat below, margins expanded; tentacles bifid, unequal, contractile; mantle covering the whole back; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; no distinct locomotive disk; external respiratory orifice connecting with a tube to the anal orifice at the extreme posterior under part of the animal; orifice of the male genital organ at the base of the right tentacle, of the female organs at the middle of the right underside of the animal. No internal shell or plate.

Jaw with numerous ribs. Lingual membrane quite peculiar, marginals quadrate.

The Veronicellæ of South America live in families, hiding

under the trunks of trees and in fissures near the water, or on dry ground, and are never truly aquatic. They quit their retreats during the night, or during the day when it rains; remaining in a torpid state during the dry season. The species of the Old World live principally upon the trees in shady places and damp parts of the forests, concealing themselves under the leaves during the greater part of the day; they crawl quickly and leave no slimy trace behind them like the Limacidæ. Their eggs are large and oval, ten or fifteen being joined together in a necklace-like, gelatinous thread, which is coiled, and more or less covered with mucus.

FAMILY VAGINULIDÆ.

Characters those of the following genus :—

VAGINULUS, Stoliczka.

Syn.—Vaginula and Veronicella, part, of authors.

Distr.—Cochin China, etc. *V. Taunaysii*, Fer. (ci, 62).

Animal limaciform, subcylindrical, high on the back, slender and pointed at tail; tentacles bifid; mantle covering the whole back; no longitudinal furrows above the margin of the foot, and no caudal mucous pore; no distinct locomotive disk? external anal and respiratory orifice at the lower right side of the mantle about two-fifths of the length of the body distant from the front; generative orifices distinct, the female with the respiratory orifice as above described, the male orifice behind and below the right eye-peduncle.

No shell.

No jaw. Lingual membrane short; teeth aculeate.

For a notice of this agnathous genus as restricted from Veronicella, see Stoliczka, Jour. Asiatic Soc. Bengal, 2d series, vol. xlii, number clxxxi, p. 33.

LIMACELLUS, Blainv., 1817.

Distr.—*L. Elfortianus*, Blainv. (ci, 63).

Animal elongated, subcylindrical; the foot covering the whole ventral surface, and only separated from the back by a groove; back enveloped in a thick skin, forming anteriorly a sort of mantle over the pulmonary cavity, the orifice of which is at the right side; generative orifices distant, that of the male at the base of the right tentacle, oviduct at the posterior part of the right side; the two communicating by a groove. A doubtful genus.

FAMILY ONCHIDIIDÆ.

Characters those of the genus Onchidium. The mantle, as in Veronicellidæ, covers the entire back; the mouth is covered by a buccal veil. Aquatic.

Includes Onchidium, without, and Peronia (Blainv.) with ramified dorsal appendages, both of Indo-Pacific distribution; also Onchidella and the doubtful genus Buchanania (Lesson).

ONCHIDIUM, Buchanan, 1800.

Syn.—Oris, Risso ?

Distr.—Bengal, West Indies, etc. *O. typhæ*, Buch. (ci, 64).

Animal limaciform, elongate-oval; tentacles wanting; mouth with lobate appendages; mantle coriaceous, tubercular, covering the whole back; no longitudinal furrows above the margin of the foot, nor caudal mucous pore; no distinct locomotive disk; external respiratory orifice under the right posterior margin of the mantle; anal orifice separate from the last, posterior; male external generative orifice under the right eye-peduncle; female orifice at posterior of under side of body.

No shell or shelly plate.

No jaw. Lingual membrane broad; teeth different in shape from those of the terrestrial genera, arranged in very obliqne rows; centrals tricuspid, side teeth all alike, bicuspid, inner cusp small, outer cusp larger, with greatly produced, oblique, squarely truncated cutting points.

This and the three following genera are marine, and are in many ways distinct from the rest of the Geophila.

In *Onchidium Celticum*, Cuv., the organ opening near the hinder end on the under side of the mantle, regarded as lungs by Cuvier, is really the renal organ, homologous to the organ of Bojanus in the bivalves; the heart is situated according to the type of the Opisthobranchia, and the respiratory function is performed by the dorsal surface of the mantle and its appendages. Consequently this species and possibly all the Onchidiidæ might well be removed from the pulmonata and placed with the marine slugs; which they further resemble in the larva possessing a ciliated velum and spiral shell.

ONCHIDELLA, Gray, 1850.

Syn.—Onchidina, Semper, 1882.

Distr.—11 sp. European Seas, Atlantic, New Zealand. *O. nigricans*, Quoy (cii, 68).

Animal ovate. The respiratory orifice is placed on the right side of the vent, and the male orifice on the right side of the tentacles; whereas in Onchidium both are in the median line, the former behind the vent, the latter behind the tentacles; no dorsal eyes. Jaw thin, scarcely distinct; median tooth of the radula tricuspid, laterals short, oblique, bicuspid; male organs more simple than in Onchidium and Peronia; large glands on the edges of the mantle.

Onchidella lives upon algæ, and is perfectly amphibious; ex-

isting for at least a month either under water or out of it (if the air is moist).

PERONIA, Blainv., 1824.

Syn.—Onchis, Fer., 1821. Oncus, Ag.

Distr.—Shores of tropical seas. *P. punctata*, Quoy (cii, 69).

Animal elongate-ovate; like the last genus, but with arbusculiform tufts and tubercles on mantle. Littoral.

BUCHANANIA, Lesson, 1830.

Distr.—Chili. *B. Oncidioides*, Lesson.

Like the last genus, but mantle smooth, with a large central tubercle and radiating striæ; oral appendages simple, subulate, retractile. Lingual dentition? The type is three-and-a-half inches long, yet has not been seen since Lesson described it, more than fifty years ago.

ORDER BASOMMATOPHORA.

Tentacles flattened-triangular or subcylindrical, contractile (but not invertible); eyes at their bases, sessile.

Shell usually covered by a corneous epidermis and oblong, few whorled, without operculum. Mostly aquatic or littoral.

Suborder GEHYDROPHILA, Fer. Teguments rugose; terrestrial, but usually inhabiting sea-shores.

Suborder HYGROPHILA, Fer. (Limnophila, Hartmann.) Teguments smooth. Fresh water.

Suborder THALASSOPHILA, Gray. Head a flattened disk, apparently resulting from the union of the tentacles to the skin of the head; inhabiting sea-shores and brackish water.

SUBORDER *GEHYDROPHILA*.

FAMILY AURICULIDÆ.

Shell spiral, covered by an epidermis, solid, usually thick; spire more or less elevated; whorls sometimes flattened; aperture elongated, contracted by columellar teeth, and often also by teeth within the lips.

Lingual membrane broad and elongated; teeth numerous, in slightly bent cross-series; central tooth equilateral, narrow, tricuspid; lateral and marginal teeth also tricuspid, rather inequilateral, diminishing in size towards the outer edge (xiii, 67). Head ending in a snout; mouth with a horny lunate upper jaw, and with two dilated buccal lobes, united above, separate below; tentacles subcylindrical, contractile; eyes sessile at the inner sides of their bases. Mantle closed, with a thickened margin; respiratory orifice posterior, on the right side. Sexes united.

Animal usually frequenting salt marshes and the vicinity of

the sea; mostly tropical in distribution, at least as to the larger species.

The inner walls of the whorls are usually absorbed, so as to form a single cavity for most of the interior (i, 14).

AURICULA, Lam., 1799.

Etym.—*Auricula*, a little ear.

Syn.—Ellobium, Bolten? 1798. Marsyas, Oken, 1815. Geovula, Swains., 1840. Auriculus, Montf., 1810.

Distr.—44 sp. East Indies, New Caledonia, South America, Philippines, Australia. *A. Midæ*, Linn. (cii, 70).

Shell oblong-oval, covered by a thin epidermis; spire short, conoidal, very rarely subelongated; last whorl large; rounded at the base; aperture longitudinal, narrow, ear-shaped; inner wall of the aperture with two or three plications; peristome thickened internally, without teeth.

A. Judæ, Linn., has truncated tentacles. The species are mostly found in brackish-water swamps, in tropical islands, and several of them are known to be blind.

SIONA, H. and A. Adams, 1858. (Sarnia, H. and A. Adams, 1855.) Shell oval-cylindrical; spire obtuse; whorls transversely striate; aperture linear; inner lip plicate; outer lip thickened within, sinuous behind. *A. avena*, Petit.

PYTHIOPSIS, Sandberger, 1870. Shell oval-conic, with a line of varices, sometimes on one side, sometimes on both sides; columellar wall with two plications, the posterior small, the anterior subhorizontal; base of the columella plicate and twisted; lip thickened within but not dentate. *A. ovata*, Lam. Eocene. This group connects Auricula with Scarabus.

AURICULASTRA, Martens. Aperture with thickened lip; shell small, with elevated spire. *A. subula*, Quoy.

CASSIDULA, Fer., 1819.

Syn.—Sidula, Gray, 1840. Rhodostoma, Swn., 1840.

Distr.—27 sp. Ceylon, East Indies, Philippines, Australasia, Polynesia. Fossil; *C. umbilicata*, Desh. Miocene of Touraine. *C. angulifera*, Petit (cii, 71).

Shell subperforated, cassidiform, solid; spire short, conoidal; last whorl very large, attenuated to the base, where it is usually carinated or angulated around the axis; aperture narrow, sinuous; inner lip dentately plicate; columellar plication strong; outer lip thickened within by a strong callosity with toothed edge.

Foot bifid behind; tentacles slim and pointed, with eyes slightly raised at their internal base.

Usually inhabits mangrove-swamps, and among loose stones near the sea-shore; some species are amphibious, and at high

tide may be noticed crawling on the sands in nearly two fathoms of water.

SCARABUS, Montfort, 1810.

Syn.—Pythia, Bolten ? 1798. Polyodonta, Fischer, 1807. Strigula, Perry, 1811.

Distr.—48 sp. India, East Indies, Philippines, Australasia. *S. Lessoni*, Bl. (cii, 73). *S. trigonus*, Trosch. (cii, 74).

Shell oval, laterally compressed; spire sharp, conoidal; all the whorls with varices upon the narrow, angulated sides; umbilicus rimate; aperture exteriorly large, reflected, interiorly much contracted by laminated lips on both sides, the edges of which are toothed. Foot oval, not bifid behind. Terrestrial, living in woods near the shores, and loving darkness; only active after a rain; ovipositing on the trunks of trees.

PLECOTREMA, H. and A. Adams, 1853.

Syn.—Lirator, Beck ? 1837.

Distr.—27 sp. Red Sea, East Indies, Philippines, Australia to Sandwich Islands. *P. clausa*, Ad. (cii, 75).

Shell oval-conic or subfusiform, solid, usually spirally grooved; spire conical, sharp; aperture oblong, contracted; columellar lip with three plicæ, one of which is bifid; peristome thickened, usually varicose, bidentate or tridentate within.

ALEXIA, Leach, Gray, 1847.

Syn.—Phytia, Gray, 1821. Ovatella, Moquin-Tandon, 1847.

Distr.—21 sp. United States, West Indies, Madeira, Europe. *A. denticulata*, Mont. (cii, 76).

Shell oblong-oval, thin, spire acuminate; last whorl large, rounded at base; columella with an oblique plait; aperture contracted by teeth, and sometimes by a callosity of the outer lip.

Tentacles cylindrical, swollen near their extremities, which are pigmented; eyes at their internal base; foot elongated, obtuse, without transverse division.

MONICA, H. and A. Adams, 1855. Shell oblong-conic, spire elevated; whorls with revolving striæ; inner lip rather thick, with three dentiform plications. European. *A. Firmini*, Payr. (cii, 93).

TRALIOPSIS, Sandberger. Columellar wall biplicate, base of columella triplicate, lip denticulated within. *A. dentiens*, Desh. Fossil. Basin of Paris.

CARYCHIUM, Müller, 1774.

Syn.—Saraphia, Risso, 1826. Auricella, Jurine, 1817.

Distr.—15 sp. Europe, Africa, United States. Fossil. Jurassic—. *C. minimum*, Müll. (cii, 77, 78).

Shell minute, conical-pupiform, very thin, hyaline; whorls not numerous; aperture suboval, usually contracted by teeth, one or two on the columellar, and frequently one on the outer lip; columella plicate, or plication obsolete.

Tentacles rather large, cylindrical, obtuse; foot thick, obtuse behind.

CARYCHIOPSIS, Sandberger. Lip with two interior teeth. *C. Dohrni*, Desh. Fossil.

LAIMODONTA, Nuttall.

Distr.—10 sp. Polynesia. *L. Sandwichensis*, Soul. (cii, 88).

Shell oblong-oval, imperforate, thin, with revolving striæ; spire elevated-conic; aperture oval; inner lip with three plications, the anterior smallest, outer lip sharp, with a transverse interior plication.

Distinguished from Ophicardelus by the internal elevated rib of the outer lip.

MARINULA, King, 1831.

Distr.—10 sp. Australia, Mediterranean, W. Coast of America. *M. pepita*, King (cii, 89).

Shell oval-oblong, imperforate, solid, smooth; spire short, sharp; aperture oval; inner lip rather thick, excavated with three plications, the posterior largest; outer lip simple, sharp.

CŒLESTELE, Benson, 1864.

Syn.—Francesia, Paladilhe, 1872.

Distr.—12 sp. India, Egypt, Arabia, Spain. *C. scalaris*, Benson (cii, 79).

Shell imperforate, elongate-cylindrical, aperture semiovate; columellar margin with a subspiral plica above; peristome thin.

MELAMPUS, Montfort, 1810.

Syn.—Conovulus, Lam., 1812.

Distr.—120 sp. Universal, mostly tropical. Fossil. Miocene of Touraine. *M. luteus*, Quoy (cii, 80).

Shell oval-conoidal, or suboval, solid; spire rather short; aperture elongated, narrow; columellar lip with several dentiform plications; columella plicate; outer lip sharp, interior with revolving ridges.

Foot truncated in front, bifid or subbifid behind, divided below into two unequal portions by a transverse groove. Jaw fibrous, slight, curved, with sharp extremities. Teeth nearly horizontal, the central smaller than the laterals—which are tricuspid, marginals serriform.

M. bidentatis, Say, is one of the commonest of salt-marsh shells on the Atlantic coast of the United States.

TRALIA, Gray, 1840. Shell oval, smooth, spire moderate; aperture narrow, linear, wider in front; columellar lip with three oblique plications; outer lip sharp, sinuous posteriorly, internally callous, with one or several strong revolving ribs. Foot not transversely divided, the posterior extremity attenuated, not bifid. West Indies. *M. pusilla*, Gmel. (cii, 81). Should, perhaps, be considered a distinct genus.

PIRA, H. and A. Adams, 1853. Shell oval, smooth; spire elevated; aperture linear; columellar lip usually with three anterior plications; outer lip with numerous revolving riblets, forming tooth-like terminations. *M. angiostoma*, Desh. (cii, 82).

TIFATA, H. and A. Adams, 1853. Shell oval or elliptical; aperture narrow, contracted, curved; columella produced, with two lamellar plications; outer lip smooth or minutely dentate within, margin acute. *M. oliva*, d'Orb. (cii, 83).

SIGNIA, H. and A. Adams, 1855. Shell decussate or granular; columellar lip with transverse plaits; outer lip with a simple elevated transverse plication upon its inner face. *M. granifera*, Mouss. (cii, 84).

PERSA, H. and A. Adams, 1853. Shell oval, with longitudinal ribs and revolving striæ; aperture rather large; outer lip sharp, smooth within; columellar lip with transverse lamellar plications. *M. costatus*, Quoy (cii, 85).

DETRACIA, Gray, 1840. Columellar wall not plicate, aperture very narrow. *M. cingulatus*, Pfeiffer. West Indies.

RHYTIPHORUS, Meek, 1873.

Distr.—*R. priscus*, Meek (cii, 87). Cretaceous; Utah.

Shell having the general aspect of Melampus, excepting that it has a series of small, oblique, short folds around the top of the somewhat shouldered whorls; while a slight curve in these little folds or costæ indicates the presence of a faint sinus in the lip near the suture; it has two folds on the columella, while the outer lip is thin, and apparently entirely smooth within.

OPHICARDELUS, Beck, 1837.

Distr.—11 sp. Australia, Polynesia. *O. Australis*, Quoy (cii, 86).

Shell oval-oblong, umbilicated, smooth; spire elevated-conic; aperture oval, elongated, angulated above; inner lip reflected, with two spiral plications, one of which surrounds the umbilicus; outer lip thin, simple.

AUTENOE, Guppy.

Distr.—*A. riparia*, Guppy. Trinidad.

Closely resembling Melampus and Laimodonta, differing chiefly from the former in its thin and horny shell, and from the latter in its short spire and longer aperture.

LEUCONIA, Gray, 1840.

Distr.—7 sp. Europe, United States, West Indies, Loo Choo Islands. Fossil. Miocene of Europe. *L. Sayi*, Küster (cii, 90).

Shell oval-oblong, thin, nearly smooth, imperforate; spire conic; aperture oval-elongated; columellar wall with one or two plaits; columella with a distinct basal plait, oblique; peristome simple, without teeth.

The Leuconias live in situations often covered by the tides. The animal has a foot truncated in front, obtuse behind, and transversely divided on the sole. The shell closely resembles Alexia.

BLAUNERIA, Shuttleworth, 1854.

Distr.—3 sp. New Caledonia, Sandwich Islands, Europe, West Indies and United States. *B. pellucida*, Pfr. (cii, 91).

Shell sinistral, imperforate, oblong-turreted, thin; aperture narrow, elongated; inner lip with a single plait, columella subtruncate; outer lip simple.

STOLIDOMA, Deshayes, 1864. (Macrodonta, Desh.) Shell oblong, turriculated, subcylindrical; apex obtuse, smooth, polished; aperture elongated, obliquely inflected, narrowed behind, widened in front; columella straight, with a large median plait, compressed, and slightly oblique. 3 sp. Eocene; Paris Basin. *B. crassidens*, Desh. (cii, 72).

The shells of this genus are Auriculæ, with a single columellar plait, without teeth or plications on the right lip.

PEDIPES, Adanson, 1757.

Distr.—11 sp. Red Sea, Mauritius, W. Africa, New Caledonia, Panama, Lower California. Fossil. Eocene; Paris Basin. *P. afer*, Gmel. (cii, 92).

Shell imperforate, oval-subglobose, solid, spirally striate, whorls few, the last very large; aperture much contracted by teeth; columellar lip with usually three dentiform plications, of which the posterior one is largest and spiral; outer lip sharp, callous or dentate within.

Foot divided inferiorly by a transverse groove. When the Pedipes walks, the hinder part of the foot is fixed, and the fore-part, which is separated from the hind-part by an extensible groove, is advanced, and the hind-half is then drawn forwards so as to touch the anterior half, and so progression is effected by a series of little steps. This movement, similar to that of the geometric or looping caterpillars, is executed with such quickness that few mollusks, according to Adanson, excel the Pedipes in alertness. The animal lives in tropical countries, in cavities of rocks, more especially of those exposed to the sea.

FAMILY OTINIDÆ.

Shell external, paucispiral, auriform or pileiform; aperture large, oval; peristome simple.

Jaw with a superior quadrangular projection as in Succinea; radula with simple, narrow, unicuspid laterals, and bicuspid marginals.

These mollusks unite with an animal resembling Auricula, the shells of an Ancylus or Lamellaria.

Differs from Auriculidæ in having flattened tentacles, and from Limnæidæ in having the eyes on the upper part of the base of the tentacles, instead of at the inner edge of the base, and in having colored shells. Amphibious.

OTINA, Gray, 1847.

Distr.—Europe. *O. otis*, Turton (ciii, 2).

Shell thin, globular-sigaretiform, paucispiral; whorls rapidly enlarging; aperture very large, oval; columellar lip smooth; outer lip simple, sharp.

Tentacles nearly obsolete; eyes sessile, on the upper part of the head at their hind bases. Foot divided by a transverse groove across its centre, and furnished with a creeping disk at each end.

These animals, whose shells so closely resemble those of Velutina, inhabit chinks of rocks between tide-marks. They progress in the same manner as Pedipes, by alternately fixing and moving forwards the anterior locomotive disk.

CAMPTONYX, Benson, 1858.

Distr.—*C. Theobaldi*, Benson (ciii, 4). India.

Shell cap-shaped, obliquely conical, with a subspiral free apex directed to the right side; surface with an external longitudinal ridge, and corresponding internal furrow extending from the apex to the right margin; aperture large, ovate, entire, expanded at the margin. The shell is like a Pileopsis, with a respiratory channel on the right side.

"Animal with the respiratory orifice on the edge of the mantle. Eyes sessile at the middle of the hinder part of the base of the tentacles, and are visible only from above; tentacles rather conical than angular; upper mandible conspicuous, slightly lobed; lingual ribbon broad, with 86 rows of teeth, 87 in a row (43.1.43); they have simple obtuse hooks as in Ancylus; the central row only differs in being symmetrical; the laterals diminish gradually from the 14th to the 43d, and a second cusp makes its appearance, and increases until the three near the margin are regularly bicuspid."—WOODWARD.

The habits of *C. Theobaldi* are terrestrial, although it lives attached to rocks, like Patella.

VALENCIENNESIA, Rousseau, 1842.

Dedicated to the late Professor Valenciennes of Paris.

Distr.—*V. annulata*, Rousseau. Associated with fresh-water shells in a tertiary deposit near Kertch, Crimea.

Shell resembles a gigantic Ancylus; apex much incurved; surface concentrically marked. A longitudinal plication extends from the apex to the right side of the posterior border, and corresponds with an internal channel; there is a second but less distinct plication on the left side.

SUBORDER *HYGROPHILA.*

Teguments smooth; living in fresh water and only coming to the surface occasionally to renew their supply of air. Tentacles contractile, with eyes at their base. Jaw simple in Physa, and compound in Limnæa and Planorbis, composed of three pieces corresponding to the three lips of the mouth, and not completely separated. Central and lateral teeth as in Helicidæ, marginals pectinate or serriform.

Male orifice near the tentacle, female at the base of the neck, near the respiratory opening. Eggs contained together in a gelatinous, transparent capsule. Embryos without velum, and undergoing but slight changes. Phytophagous (Physa is sometimes carnivorous). Swimming in a reversed position at the surface of the water.

FAMILY LIMNÆIDÆ.

Shell thin, horn-colored, mostly spiral, sometimes patelliform, capable of containing the entire animal contracted; aperture simple, rounded; lip sharp.

Lingual membrane armed with numerous quadrate teeth, arranged in transverse rows, the central minute, the laterals uncinated, the marginals multicuspidate (xiii, 64, 65). Head with a broad, short muzzle dilated at the end; mouth with a horny upper jaw, composed of three pieces, the central much the largest (xiii, 66); tentacles flattened or filiform, with the eyes sessile at their inner bases. Mantle-margin variously modified, respiratory orifice at the right side. Foot flattened, lanceolate or ovate.

The fresh-water, air-breathing mollusks of which this family is composed inhabit the rivers, ponds, and running streams in all parts of the globe, being, however, most numerously represented in temperate regions. They feed on Confervæ and other aquatic plants. Although usually to be seen crawling on the muddy bottoms and on the stems and foliage of submerged vegetation, they come to the surface to respire the free air, and sometimes may be observed gliding, shell downwards, on the

surface of the water, anchoring or letting themselves down occasionally by means of a glutinous thread. As is frequently the case in fluviatile shells, the apex of the spire is usually eroded. A. Pauly has studied the respiration of the Limnæidæ, and from numerous observations and experiments, comes to the following conclusions: The Limnæidæ, under natural conditions, come to the surface of the water in order to breathe air at intervals varying from a few minutes to several hours, chiefly according to the facility of reaching the surface by creeping. Under water the pulmonary orifice is kept closed, and is not extended by water; only very young snails have it open and filled with water, and this only before they begin to breathe air. If bubbles of air are present, as in shallow ponds containing many water-plants, or in an aquarium, the Limnæidæ make use of these bubbles for their respiration. Adult specimens kept from air can survive for ninety days, but they respire only by the skin, and never use the pulmonary sac as a water-respiring organ. But as the young snails, in the egg and some time after being hatched, receive water in their pulmonary orifice, it is possible that those which live at a considerable depth may retain this sort of respiration during their whole life, together with respiration by the skin. S. Clessin thinks that the Limnæidæ normally respire water, and that they are compelled to come to the surface and respire air only by unusually high temperature. (Mal. Bl., xxiv, pp. 175, 176.)

The following arrangement of the genera of the family is mainly that proposed by Mr. Wm. H. Dall.

SUBFAMILY *LIMNÆINÆ.*

Shell spiral, the spire more or less elongated.

LIMNÆA, Lam., 1798.

Etym.—*Limnaios*, marshy. Pond-snail.

Distr.—200 sp. Europe, Asia, America, north of the Equator, Polynesia. Fossil, 75 sp. Wealden—, Europe; Laramie—, N. America.

Shell normally dextral, oval-oblong, thin, corneous, translucid; spire sharp, more or less acuminated; last whorl ventricose; aperture oval, ample, rounded in front; columellar lip with an oblique plait entering above.

When the ponds are dried up in seasons of drought, these animals bury themselves in the mud, strengthen the outer lip of their shells by an internal rib, and close the aperture by means of an epiphragm like hibernating Helices. Their mode of propagation is very singular—three or more individuals being united in a chain for that purpose. Leach has remarked that, in consequence of the sexual parts being distant from each other, one

individual is able, at the same time, to perform the function of each sex with two others.

Bulimnæa megasoma, Say (ciii, 5), is partially carnivorous (Wetherby). Mr. Whitfield has recorded some singular changes produced in successive generations, the progeny of a single individual, confined in an aquarium. They gradually diminished in size and the male organs disappeared. Prof. Hyatt has ascribed these changes to different conditions of temperature, but it was probably due also to deficient food-supply, and an effect of the physiological law to which Mr. Meehan has so frequently called attention in plants, namely, of the greater persistence, in cases of depauperization, of female functions and members.

LYMNUS, Montf. Typical. (Auricula, Klein.) *L. stagnalis*, Linn. (ciii, 9).

RADIX, Montf., 1810. (Neristoma, Klein [teste Adams]. Gulnaria, Leach [teste Turton].) Shell suboval-globular; last whorl ventricose; aperture very large; columella plaited. *L. auricularia*, Linn. (ciii, 6).

POLYRHYTIS, Meek. Much like the last in form, but bearing distinct, regular, vertical costæ. *L. Kingi*, Meek. Tertiary; Utah.

BULIMNÆA, Haldeman, 1841. Shell oval, subglobular, large, the spire short, apex sharp; aperture moderate. *L. megasoma*, Say (ciii, 5).

LIMNOPHYSA, Fitzinger, 1833. Shell oval-oblong, spire elevated; aperture narrowly ovate, about half the length of the shell. *L. reflexa*, Say (ciii, 7).

LEPTOLIMNÆA, Swainson. (Omphiscola, Raf.) Shell nearly cylindrical; spire thick, lengthened; aperture small. *L. glabra*, Müll.

ACELLA Hald., 1841. Shell elongated, very slender; whorls 4–6, very oblique, but slightly convex; aperture small, ovate, expanded below. *L. gracilis*, Jay (ciii, 8).

PLEUROLIMNÆA, Meek. Shell differing from the last in having small, regular surface-costæ parallel to the lines of growth, and aperture narrowed or subangular, instead of rounded anteriorly. *L. tenuicostata*, Meek and Hayden. Fossil. Eocene; Dakotah. ? = Acella.

VELUTINOPSIS, Sandberger. Oval, neritiform, spire excavated, last whorl very large, columellar lip depressed. *L. velutina*, Desh. Tertiary; Crimea.

Some of the species of Limnæa inhabiting the Sandwich Islands and New Zealand are sinistral. Limnæa adapts itself to very diverse conditions; it is found in Greenland and Iceland, in hot and sulphurous springs, in fresh or brackish water. *L. Hookeri* occurs in Thibet, at an elevation of nearly 14,000 feet; *L. abyssicola* in the Lake of Geneva, at a depth of 800 feet.

AMPHIPEPLEA, Nilsson, 1822.

Syn.—Myxas, Leach, teste Turton, 1831.

Distr.—18 sp. Europe, East Indies, Australia, Philippines. *A. glutinosa*, Müll. (ciii, 10).

Shell globular, ventricose, thin, transparent; spire very short, depressed; aperture very large; columella without fold; outer lip sharp.

Animal with the mantle-margins developed, partly covering the shell; tentacles flat, triangular.

ERINNA, H. and A. Ad., 1858.

Distr.—Sandwich Islands, Isle of Bourbon. *E. Newcombi* — H. and A. Ad. (ciii, 11).

Shell semiglobose, thin, horny, olivaceous, longitudinally finely striated; spire very short, obtuse, apex rather eroded, last whorl ventricose; aperture large, semiovate; inner lip posteriorly ascending on the body-whorl; columella straight, excavated, and with a curved, elevated, external ridge continued in front into the outer lip, which is simple and acute.

The shell much resembles Lithotis, Blanford, but the descriptions of the animals differ.

LANTZIA, Jousseaume, 1872.

Distr.—*L. carinata*, Jouss. Isle of Bourbon. Living in moss, at 1200 metres altitude.

Shell auriform, with very short spire, last whorl tricarinate; peristome thickened within; columellar lip flattened, forming a septum. Foot large; tentacles flattened, triangular, with eyes on prominences at their base, interiorly; jaw fibrous, of three segments.

? CANEFRIA, Issel, 1874.

Distr.—*C. splendens*, Issel. Borneo.

Shell small, cylindrically conical, summit truncated by erosion, suture lacerated, irregular, aperture entire, without plications or teeth, lip simple.

Appears to partake somewhat of the characters of Auricula.

PHYSA, Draparnaud, 1801.

Etym.—*Physa*, a pouch.

Syn.—Rivicola, Fitz., 1833. Isidora, Hald.

Distr.—100 sp. North America, Europe, East Indies. Fossil. 43 sp. Wealden—, Europe; Cretaceous—, N. Am. *P. ancillaria*, Say (ciii, 12). *P. fontinalis*, Linn. (ciii, 13).

Shell ovate, sinistrally spiral, thin, polished; aperture rounded in front.

Animal with long, slender tentacles; the eyes at their bases; mantle-margin expanded and fringed with long filaments. Jaw

in one piece, arcuated, finely striated with a superior, central fibrous projection, recalling the accessory plate in Succinea. Radula composed of oblique teeth, the central multicuspid, the laterals and marginals serrated and furnished with a small, narrow, special appendage at their superior, outer margin.

PHYSELLA, Hald., 1842. Shell very small, globular, with short and small spire; aperture oval, ample; columella with a well-marked plication. *P. globosa*, Hald. (ciii, 15).

PHYSODON, Hald., 1842. Shell oval-elliptic, rather solid; columella toothed. *P. microstoma*, Hald. (ciii, 16).

COSTATELLA, Dall. Shell longitudinally, laminately costate. *Ph. costata*, Newc. (ciii, 17).

APLEXA, Fleming, 1828.

Syn.—Nanta, Leach, 1831.

Distr.—25 sp. Europe, North America, Northern Asia. Fossil. Eocene of Europe and United States. *A. hypnorum*, L. (ciii, 19).

Shell sinistral, thin, elongated, polished; spire conical, acuminated, with scarcely indented sutures; aperture narrowly elongate-oval; columella simple; outer lip sharp. Animal with plain mantle-margins.

MACROPHYSA, Meek, MSS. Spire enormously elongated, body-whorl and aperture small. *B. columnaris*, Desh. (ciii, 20.) Paris Basin.

BULINUS, Adanson, 1757.

Syn.—Isidora, Ehrenberg, 1831. Diastropha, Gray, 1840.

Distr.—Mediterranean region, W. Indies, Oceanica.

Shell like Physa, oval, with very convex whorls and deep sutures, apex obtuse; an umbilical slit; columella twisted; peristome simple.

Animal resembling Aplexa; jaw in three plates; radula with bicuspid central, tricuspid laterals, serrated marginals.

PHYSOPSIS, Krauss, 1848.

Distr.—Africa. *P. Africana*, Krauss (ciii, 21).

Shell like Physa, but columella truncate below.

PLATYPHYSA, Fischer, 1883. Last whorl enlarged at the shoulder; columella truncate below. *P. Prinsepi*, Sowerby. Eocene; India.

PYRGOPHYSA, Crosse, 1879. Spire turreted. Africa. Madagascar. Probably passes into Isidora, Ehrenb. *P. Wahlbergi*, Krauss. Africa.

AMERIA, H. Adams, 1861. (Glyptophysa, Crosse, 1870.) Shell spirally sculptured, the body-whorl sometimes smooth, not glossy. 2 sp. New Caledonia, Australia. *P. lirata*, Trist. (ciii, 18).

PLESIOPHYSA, Fischer, 1883. Shell rather short. Central tooth of the radula 5-cuspidate, the median cusp the longest. *P. striata*, d'Orb. W. Indies.

PECHAUDIA, Bourg., 1882. Shell like Physopsis, but dextral, oval, transparent; columellar axis with a white lamella, strongly truncate at the base. *P. Letourneuxi*, Bourguignat. Algiers.

CAMPTOCERAS, Benson, 1842.

Distr.—3 sp. Swamps, in India. *C. terebra*, Benson (c, 35). 1 fossil species. Eocene; Sheerness-on-Sea, England.

Shell sinistral, imperforate; whorls three or four, separate, flat, carinated above and below; suture widely and profoundly excavated; aperture large, elongate-elliptical; peristome thin, continuous.

Animal has two obtuse, filiform tentacles, with large eyes placed between them; mantle not larger than the lips of the shell; foot short.

The description of the animal corresponds nearly with the Limnophila, and the sinistral shell has caused authors to place it in Physadæ.

CHILINA, Gray, 1831.

Syn.—Dombeya, d'Orb, 1837. Potamophila, Swn., 1840.

Distr.—18 sp. South America. Fossil, 1 sp. Miocene; S. Am. *C. puelcha*, d'Orb. (ciii, 22). It replaces the Limnæa of North America; lives in clear running streams.

Shell dextral, oval, rather thin, usually ornamented with dark spots or wavy bands; columella thickened, with one or two strong, prominent folds, peristome simple. Tentacles large, flattened, with sessile eyes at their superior face; pulmonary pouch with a well-developed protecting lobe; foot large, dilated in front, attenuated behind; genital orifices on the right side. No jaw? Central tooth small, 5-cuspidate, laterals and marginals multicuspidate, with a superior, external prolongation.

PSEUDOCHILINA, Dall, 1870, Shell thin, covered with a rough fibrous epidermis; spire elevated, acute. *C. Limnæformis*, Dall. Chili.

PITHARELLA, Edwards, 1860.

Distr.—*P. Rickmani*, Ed. "Woolwich and Reading Series," Peckham and Dulwich, London.

Shell partaking of the characters of Limnæa and Chilina, subcylindrical; aperture oval, rounded in front, narrowed behind; columella straight, or very obliquely twisted, arched anteriorly; outer lip simple, acute; inner lip thickened.

The species is associated with estuarine shells, remains of mammals and terrestrial plants.

SUBFAMILY *POMPHOLIGINÆ.*

Shell depressed globular, spiral, the spire but slightly raised.

POMPHOLYX, Lea, 1856.

Distr.—California. *P. effusa*, Lea (ciii, 23).

Shell dextral, rotund-gibbous, reflexed beneath, flattened above, not umbilicated; spire convexly depressed; aperture very large, subcircular, expanded; outer lip acute, inner lip thickened and slightly flattened.

Buccal plate subcordiform; lateral jaws absent; genitalia on the left side (in Limnæa on the right); tentacles stout, cylindrical, slightly globose at the tips; eyes sessile on the front of the head near the inner bases of the tentacles.

In some individuals there is an aggregation of pigment-cells near the tips of the tentacles, which has been taken for a second pair of eyes, but it is nearly or entirely absent in others.

Like the next genus, the shell is dextral whilst the animal is sinistral.

CHOANOMPHALUS, Gerstfeldt, 1859.

Etym—*Choanos*, a funnel; *omphalos*, an umbilicus.

Distr.—*C. Maacki*, Gerst. (ciii, 24). Lake Baikal.

Shell dextral, nearly planorbiform, the spire being scarcely raised, widely umbilicated; aperture small, rounded, the extremities of the simple peristome united by a thin parietal callus.

Animal resembling Planorbis in its tentacles, jaw and dentition; genital, respiratory and anal orifices on the left side.

PŒCILOSPIRA, Mörch. Proposed for *Planorbis multiformis*, Zieten, a miocene fossil of Steinheim, remarkable for polymorphism, and presenting all stages of form between discoidal and conical, the last whorl in contact or reflected.

CARINIFEX, Binney, 1865.

Syn.—Megasystropha, Lea.

Distr.—*C. Newberryi*, Lea (ciii, 25). California.

Shell dextral, spiral, inflated, angular, horn-colored; spire elevated, terraced; last whorl very large, broad above, very rapidly attenuated below; umbilicus funnel-shaped; aperture triangular, broad above, narrow below; inner lip slightly thickened; outer lip thin, acute, angular above, flexuose.

VORTICIFEX, Meek, 1870. Shell thicker, with a smaller umbilicus, with strongly marked growth-ribs, and without revolving carinæ (except when young). *C. Binneyi*, Meek (ciii, 26). Tertiary; Nevada.

SUBFAMILY *PLANORBINÆ.*

Shell spiral, the volutions in the same plane, so that the spire

and umbilicus are both depressed. Tentacles slender, filiform; foot short; locomotion very slow.

PLANORBIS, Guettard, 1756.

Syn.—Coretus, Adanson, 1757. Orbis, Schröt. Spirodiscus, Stein.

Distr.—150 sp. World-wide. Fossil, 70 sp. Lias—.

Shell discoidal, biconcave, the whorls visible on both sides; aperture small, rounded; margin usually simple, sometimes expanded.

Animal with a short, round foot; head short, with sessile eyes at the inner bases of the slender tentacles. Lingual teeth subquadrate, central bicuspid, laterals tricuspid, marginals serrated. *P. contortus*, a minute European species, has above 6000 teeth.

The plan of the spiral in this genus is such as to yield readily to pressure; hence monstrosities are rather frequent. They consist of a tilting up of the whorls on one side or even a conical elevation of the spire. The smaller species, in America and Europe, appear to be most liable to these distortions—*P. contortus* particularly so.

Type, *P. corneus*, Linn. (ciii, 27). Europe.

TAPHIUS, H. and A. Adams, 1855. Shell strongly excavated around the umbilicus, whorls irregularly rounded; aperture oval, expanded; columellar lip straight, oblique. *P. Andicolus*, d'Orb. (ciii, 28). So. America.

HELISOMA, Swains., 1840. Shell ventricose, paucispiral, frequently carinated around the spire; each whorl nearly enveloping its predecessor. *P. bicarinatus*, Say (ciii, 29). United States.

PLANORBELLA, Hald., 1842. Shell paucispiral; aperture oblong, somewhat irregular, the whorl swollen behind it. *P. campanulatus*, Say (ciii, 30). United States.

ADULA, H. Adams. Shell with the whorls rounded and numerous, deeply umbilicated on the upper, and convex on the lower side; aperture campanulate. *Pl. multivolvis*, Case. Northern Michigan.

MENETUS, H. and A. Adams, 1855. Shell depressed; whorls rapidly enlarging, usually angulated; aperture very oblique. *M. heloïcus*, d'Orb. (ciii, 31). So. America.

GYRAULUS, Agass., 1837. (Nautilina, Stein, H. and A. Adams, 1855. Girorbis, Agass., 1837.) Shell discoidal, whorls few, rapidly enlarging, periphery sometimes carinated; last whorl sometimes deflected. *P. deflectus*, Say.

BATHYOMPHALUS, Agass., 1837. (Spirorbis, Swains., 1840.) Shell depressed; whorls numerous, rounded, not carinated. *P. anatinus*, d'Orb. (ciii, 32). So. America.

ANISUS, Studer, 1820. (Trophidiscus, Stein.) Shell much

depressed, whorls numerous, carinated; aperture oblique. *A. kermatoïdes*, d'Orb. (ciii, 33).

DREPANOTREMA, Crosse and Fischer. Whorls subglobose, the last enveloping, aperture narrowly lunate. Central America. *P. Ysabalensis*.

SEGMENTINA, Fleming, 1830.

Syn.—Discus, Hald., 1840. Segmentaria, Swains., 1840.

Distr.—Europe, Asia, Australia. *S. lacustris*, Lightf. (ciii, 34). Europe.

Shell flattened; whorls usually laterally compressed, with angulated periphery, the last whorl embracing, internally contracted by periodic lamellæ, usually three in number, and occurring three times in each volution.

PLANORBULA, Hald., 1840. Shell discoidal, with rounded whorls, divided interiorly at intervals by septa consisting of five lamelliform teeth. *S. armigera*, Say (ciii, 35, 36). United States.

SUBFAMILY *ANCYLINÆ*.

Shell non-spiral, patelliform or conical.

ANCYLUS, Geoffroy, 1767.

Etym.—*Ancylus*, a small round shield. River limpet.

Syn.—Angulus, Mühlfeldt.

Distr.—50 sp. North and South America, Europe, Australia. Fossil, 8 sp. Eocene, Europe; Laramie —, United States. *A. concentricus*, d'Orb. (ciii, 37).

Shell conical, limpet-shaped, thin; apex posterior, turned to the left; aperture with entire, basal margin; interior with a sub-spiral muscular scar.

Animal with large oval foot; tentacles triangular, with eyes at their internal bases; jaw thin; central tooth very small, laterals bicuspidate, marginals saw-like.

ANCYLASTRUM, Moquin-Tandon, 1853. Genital and pulmonary orifices on the left side. Apex of the shell inclining to the right. *A. fluviatilis*, Müller.

ACROLOXUS, Beck, 1837. (Velletia, Gray, 1840.) Apex sinistral; shell narrow, oblong. Animal with genital and pulmonary openings on the right side. *A. lacustris*, Linn. (ciii, 38). 3 sp. Europe, West Indies, United States.

CUMINGIA, Clessin. Shell conical, top coiled, aperture oval. *A. Cumingianus*, Clessin.

HALDEMANIA, Clessin. Shell conical, top slightly excentric, but not bent backwards, aperture rounded or oval. *A. obscurus*, Hald. United States.

LANX, Clessin. Shell large, patelliform, elevated at the extremities, thin, with concentric striæ; apex very obtuse, rounded; aperture ovate, the margin acute. *A. Newberryi*, Lea.

BRONDELIA, Bourg., 1860. Apex more minute than in the type, sinistral, with a persistent spiral nucleus. Terrestrial, living on humid rocks in the forest of Edough, Boue (Algeria).

LATIA, Gray, 1849.

Distr.—2 sp. New Zealand. Fossil, 1 sp. Eocene; Idaho. *L. neritoides*, Gray (ciii, 39).

Shell ancyloid, with subspiral summit; the interior is provided posteriorly with a semicircular transverse ledge or plate, attached to the shell on the left, turned up and notched on the right side.

Animal with elongated foot, well distinguished from the mantle; eyes external to the tentacles; no jaw? Central tooth bicuspid, laterals unicuspid, marginals tricuspid.

GUNDLACHIA, Pfeiffer, 1849.

Dedicated to Dr. Gundlach, a distinguished Cuban conchologist.

Syn.—Poeyia, Bourg., 1860.

Distr.—5 sp. United States, Cuba, Tasmania. Fossil. Basin of Mayence. Pliocene; W. Indies. *G. ancyliformis*, Pfr. (ciii, 40).

Shell very small, thin, obliquely conic, apex inclined posteriorly and to the right; base two-thirds closed by a flat, straight-edged shelf, leaving a semicircular aperture.

Radula; central tooth bicuspid, laterals and marginals multicuspid.

Poeyia was described from a young Gundlachia without septum; on the other hand the young of *Ancylus textilis*, Guppy, of Trinidad, are sometimes provided with a septum, sometimes without it; so that the presence or absence of the septum is not always a sure means of distinguishing the genera.

ACROCHASMA, Reuss, 1860.

Distr.—*A. tricarinatum*, Reuss (cii, 94), from the fresh-water limestones (Miocene) of Bohemia.

Shell trilateral, pyramidal, rounded below in its whole amplitude, with one posterior concave, and two lateral slightly convex planes, ending upwards in an acute reflected apex, beneath with a longitudinal aperture through the shell, which in its living state appears to have been covered with an epidermis. It may be considered as a fresh-water representative of the marine genus Puncturella.

This, and the genus Valenciennesia, previously described, may belong to the family Siphonariidæ.

SUBORDER *THALASSOPHILA*.

Head a dilated disk without distinct tentacles, the eyes sessile on its upper surface; pulmonary pouch protected by a valvular

appendage of the mantle, with, in Siphonaria, a branchia in addition.

Three families are admitted.

Spiral, operculate. Amphibolidæ.

Conical (limpet-like), not operculate. Siphonariidæ, Gadiniidæ.

FAMILY AMPHIBOLIDÆ.

Shell spiral, subglobose, operculated.

Animal with the external features and dentition of the pulmonata, but the respiratory cavity only communicates with the free air by a small valvular opening. Aquatic, living in brackish water.

They partake of the characters both of the aquatic pulmonata and of the Ampullariidæ, and might be considered as related to that family perhaps quite as much as to the former.

AMPHIBOLA, Schumacher, 1817.

Syn.—Ampullacera, Quoy, 1832. Thallocera, Swains., 1840.

Distr.—New Zealand. *A. nux-avellana*, Chemn. (ciii, 41).

Shell subglobose, rather thick, rugose, umbilicated; spire short, whorls shouldered above; umbilicated; aperture suboval; columellar lip callous; columella flattened and reflected; outer lip sinuous posteriorly; operculum corneous, subspiral.

Lingual membrane large, very broad, expanded, and long, with a central space or line scarcely defined; teeth numerous, equal, similar, four-sided, rather longer than broad, in straight cross-lines, with a broad rounded lobe, rather more sinuous on the inner than on the outer side of its front edge. Eyes sessile on the front part of the cephalic disk formed by the expanded tentacles. Respiratory cavity closed, except a small valvular opening on the right side.

The animals of this family inhabit salt marshes near the sea, the living shells sometimes having Serpulæ attached to them. They appear to respire the free air. The Amphibolidæ offer an exception to the general rule, that pulmonifers with a closed mantle-cavity are destitute of opercula. They live in pools of brackish water, and at certain seasons bury themselves in the sandy mud. The New Zealanders collect and employ them as articles of food.

AMPULLARINA, Sowb., 1842. Shell thin, globular, umbilicated; spire short; whorls rounded; inner lip simple; outer lip sinuous in the middle. *A. fragilis*, Quoy (ciii, 42).

FAMILY SIPHONARIIDÆ.

Characters those of the typical genus.

SIPHONARIA, Sowerby.

Distr.—90 sp. Cape, India, Philippines, Australia, New Zea-

land, Pacific, Galapagos, Peru, Cape Horn, West Indies, W. Coast of N. America. Fossil, 3 sp. Miocene—; France. Type, *S. sipho*, Sowerby (cii, 97).

Shell somewhat like Patella; apex subcentral, posterior; muscular impression horseshoe-shaped, divided on the right side by a deep siphonal groove, which produces a slight projection on the margin.

Animal with a broad head, bilobed but not tentaculate; eyes sessile on prominent rounded lobes; pulmonary chamber covered by a lobe of the mantle; the rudimentary branchiæ form triangular folds of the lining membrane of the mantle, connected by a raphe. The Siphonariæ are found between tide-marks, like limpets.

SIPHONARIA (restricted), Dall. Shell solid, porcellanous; apex central or subcentral; provided with more or less elevated radiating ribs or ridges, which by their projection render the margin irregular. *S. gigas*, Sowb.

LIRIOLA, Dall, 1870. Shell thin, horny; smooth, or furnished with fine radiating lines, which do not interrupt the margin; apex marginal or submarginal, twisted to the left of the median line in most of the species. *S. thersites*, Carp.

ANISOMYON, Meek, 1860. (Allerya, Mörch. Scutulum, Monts.) Shell thin, fragile, with subcentral apex, spiral in young individuals, and obliterated siphonal fold. Jaw thin, flexible, striated. *S. patelliformis*, Meek and Hayden (cii, 95). The type is a cretaceous fossil, but several recent shells also belong here.

? HERCYNELLA, Kayser. Shell large, rounded in outline, unsymmetrical, the summit drawn to one side; surface finely radiately or concentrically striated, with a strong fold proceeding from the apex to the border, and a corresponding depression within the shell. *H. Beyrichi*, Kayser. U. Silurian.

FAMILY GADINIIDÆ.

Characters those of the typical genus.

GADINIA, Gray, 1824.

Syn.—Mouretia, Sowb., 1834. Rowellia, Cooper, 1865.

Distr.—10 sp. Mediterranean, Red Sea, Africa, Peru, W. Coast of N. Am. *G. afra*, Gray (cii, 96). Fossil, 1 sp. Sicily.

Shell obliquely conical; muscular impression horseshoe-shaped, the right side shortest, terminating at the siphonal groove.

Animal pulmoniferous, without gills; rostrum bifid.

Class SCAPHOPODA.

Shell a hollow cylinder, open at both ends. Head rudimentary; foot vermiform, lobulate; nervous system simplified, resembling that of the lamellibranchs.

The shells of the Scaphopoda are immediately distinguishable from those of all other living mollusks by external form, being straight or slightly curved tubes, without spire.

Family DENTALIIDÆ.

Shell tubular, symmetrical, curved, open at each end, attenuated posteriorly; surface smooth or longitudinally striated; aperture circular, not constricted.

Animal attached to its shell near the posterior anal orifice; head rudimentary, eyes 0, tentacles 0; oral surface fringed; foot pointed, conical, with symmetrical side-lobes, and an attenuated base, in which is a hollow communicating with the stomach. Branchiæ 2, symmetrical, posterior to the heart; sexes separated.

The tooth-shells are animal-feeders, devouring foraminifera and minute bivalves; they are found in sand, or mud, in which they usually bury themselves.

Sars divides the Scaphopoda into two orders: I think that his distinctive characters are barely sufficient to be used in a subfamily sense.

Subfamily *DENTALIINÆ.*

Posterior aperture of the shell entire or with a ventral slit, provided with a supplementary tube. Foot trilobate. Edge of the lateral plates of the radula indistinctly dentate. (Order Scaphopoda, Sars.)

Dentalium, Linn., 1758.

Distr.—75 sp. Universal. *D. elephantinum*, Linn. (ciii, 98).

Animal with a short foot, anteriorly thickened and tripartite. Shell tube-like, gradually tapering posteriorly, longitudinally ribbed, margin of the aperture sharpened, posterior end with an internal, slightly projecting tube, which is provided with a dorso-ventrally elongated opening, the outer layer having a very slight emargination dorsally and ventrally.

"The Dentalium burrows in the sand by means of its conical foot, in a slanting direction; the narrow end is, of course, uppermost, and is kept in communication with the air or water for the purpose of respiration. It feeds on foraminifera and other

minute organisms, which it catches with its thread-like tentacles. These are all lengths and sizes, and are insinuated among the grains of sand on every side; they are covered with cilia, especially at the points, which resemble suckers. They are thrown off by the Dentalium under certain conditions, and may occasionally be seen detached and wriggling like taper hair-worms. Terebella and other tubular annelids have similar organs. Being highly contractile, these tentacles convey the food to the funnel-shaped mouth, in which, by the aid of the labial and ciliated palps, the animalculæ are quickly engulfed; then the masticatory apparatus comes into play. This consists of a tongue or lingual riband, armed with five rows of sharp spines, one in the middle, and two on each side.

"The shelled Foraminifera found in the stomach of a Dentalium are perfect, and the sarcode must be extracted from them by some secretion answering to the gastric juice of the Vertebrata. The Dentalium has no eyes; they would be useless to an animal always buried in the sand. They have otolites or ear-stones, which serve as organs of hearing; these are extremely numerous, calcareous and globular, and are enclosed in two nearly spherical pouches, lined with vibratile cilia, which are in constant action, and agitate the otolites by an incessant tremulous movement. The organs of circulation and respiration are of a rudimentary kind; there is no heart. The sexes are separate. There are no external organs of generation, but impregnation is effected by the male emitting his spermatozoa, and the female her eggs at the same time in the water. The process may be compared to the chance shedding of pollen in the air by diœcious plants. Lacaze-Duthiers noticed that the spermatozoa lived six hours after performing the act of fecundation. The egg is at first oval, afterwards pear-shaped, and ultimately divided into segments like those of an Annelid. Such eggs as do not arrive at maturity speedily decompose and are cleared out by swarms of infusoria, which appear to be generated from the corruption. In the first stage of development the germ is motionless; in the second stage it is propelled by vibratile cilia, which are set around a large lobe in front, similar to that observable in the larvæ of many mollusca, and it swims rapidly; in the third stage it crawls by means of a disk-like foot. In swimming it does not come to the surface of the water, as do the fry of the oyster and other mollusca. The shell is formed during the third period, but is only detected by its iridescent lustre, being exceedingly thin and transparent, a mere film. This state continues until the fifth and occasionally the sixth day after birth. The embryonic period lasts from thirty-five to forty days. If any of the fry die, Paramecia and Ploesconiæ (infusoria) are bred from the decaying matter, and, entering the shells

of living individuals, soon destroy them. Lacaze-Duthiers observed a current of water passing through the shell from the opening at the smaller end. He discovered the Dentalium at low-water mark, where its presence was betrayed by a small groove in the sand; and he seems to have got a knack of finding them, for he says he easily procured 200 live specimens at the recess of a single high spring-tide. They prefer certain spots, especially patches of coarse sand mixed with broken shells and interspersed with Zostera. The Dentalium is hardy, and apparently abstemious. Lacaze-Duthiers kept some alive in a flask of sea-water with a little sand for more than eighteen months. It is much more active at night, and sensible of light. A ray of the sun or the flame of a candle will cause it to withdraw its foot. This organ acts as a piston in expelling at the other end the eggs and seminal fluid, as well as, perhaps, the fæces and exhausted water. The point of the young shell is pear-shaped, and bears some resemblance to a baby's feeding-bottle with the hole at one end instead of in the middle. It is broken off when too small to contain the terminal tube or process of the mantle; and this part of the shell is continually rubbed away as the animal increases in size, until at last it becomes truncated, and a short pipe is formed with an oblique slit in front to accommodate the terminal tube. The slit is extended in certain species, although this distinctive character is confined to adult specimens. The inside of the shell is white as porcelain, and brilliant as varnish. The epidermis is slight and easily abrades. The microscopic structure of the shell is scarcely different from that of Patella. It is most complicated, being composed in a great measure of prisms, interlacing fibre, and anastomosing canals—not of cellular elements. The quantity of animal matter which it contains is next to nothing.

"Mr. Lord says that these shells were employed as money by the Indians of Northwest America before the introduction, by the Hudson's Bay Company, of blankets, which to a great extent superseded the tooth-shells as a medium of purchase. 'A slave, a canoe, or a squaw, is worth in these days so many blankets; but it used to be so many strings of Dentalia.' The value of a Dentalium depends upon its length. Twenty-five long shells, strung together end to end, make a fathom, and are called a 'Hi-qua.' At one time such a string would have been worth about £50 sterling. The shells inhabit the soft sand, in the snug bays and harbors that abound along the west coast of Vancouver's Island, at a depth of from 3 to 5 feet. The habit of the Dentalium is to bury itself in the sand, one end of the shell being invariably downwards, and the other end close to the surface. 'This position the wily savage turns to good account, and has adopted a most ingenious mode of capturing the much-prized

shell. He arms himself with a long spear, the shaft made o. light deal, to the end of which is fastened a strip of wood placed transversely, but driven full of teeth made of bone, resembling exactly a long comb with the teeth very wide apart. A squaw sits in the stern of the canoe, and paddles it slowly along, whilst the Indian with the spear stands in the bow. He now stabs the comb-like instrument into the sand at the bottom of the water, and after giving two or three such stabs draws it up to look at it; if he has been successful perhaps four or five Dentalia have been impaled on the teeth of the spear.' At one period, perhaps a remote one in the history of the inland tribes of Indians, Dentalia were worn as ornaments; these are found in old graves, quite 1000 miles from the sea, mixed with stone beads and small bits of nacre of the Haliotis, of an irregular shape, but with a small hole drilled through each piece."—JEFFREYS, *Brit. Conch.*

D. ergasticum, a monster species, dredged by the "Travailleur," is nearly four inches (9 cm.) long.

ANTALE, Aldrov. (Pyrgopolon, Montfort. Entalium, Defrance. Pharetrium, König.) Shell tubular, much prolonged, smooth, the posterior end with entire margin, the internal tube slightly projecting, and usually with a roundish opening. *D. Tarentinum*, Lam. Europe.

ENTALIS, Gray, 1840. (Antalis H. and A. Ad., *ex parte*.) Shell tube-like, slightly curved, longitudinally ribbed or sometimes striated, gradually tapering towards the posterior end, which has the margin on the ventral or convex side provided with a short and broad fissure. Type, *D. entalis*, Linn. *D. Delesserti*, Chenu (ciii, 1). The posterior end is usually longitudinally striated even when these striæ or ribbings become obsolete towards the aperture. The supplementary or embryonal projecting tube is not always present, being frequently lost.

FUSTIARIA, Stoliczka, 1868. Shell tubular, thin, usually slightly curved, smooth, posterior end with a long, linear slit on or near the ventral side. *D. eburneum*, Lam.

SUBFAMILY *SIPHONODENTALIINÆ*.

Posterior aperture of the shell entire or with several notches, and without supplementary tube. Foot elongated, worm-like, provided at the tip with a circular disk, the edges of which are beset with papillæ; edge of the lateral plates of the radula distinctly tridentate. (Order Siphonopoda, Sars.)

The shells resemble the Dentaliinæ, but as they appear usually to inhabit deep waters they always consist of a thin substance; the posterior end is generally less pointed and more widely opened.

SIPHONODENTALIUM, M. Sars, 1859.

Distr.—*S. vitreum*, Sars (ciii, 100). N. Europe.

Shell slightly attenuated, apex incised-lobate. Terminal pedal disk concave in the middle, no median tentacles.

The posterior orifice exhibits two slight notches on each side, and the foot is ordinarily vermiform and pointed, expanding only in a flower-like shape when the animal uses it as a fulcrum.

PULSELLUM, Stoliczka, 1868. (Siphonoentalis, G. O. Sars.) Shell tubular, thin, smooth or longitudinally ribbed, gradually tapering towards the posterior end, which is truncate, with the margin entire. The animals closely resemble those of *Siphodent. vitreum*, only showing slight differences in the ciliated fringe of the foot-disk, but the shells are readily distinguished from it by the entire margin of the posterior end; this distinction also applies as regards Dentalium, but the separation from Antale is more difficult, being apparently restricted to the more truncated shape of the posterior end in the present genus, and to a more hyaline structure of the shell. *S. Lofotensis*, Sars.

CADULUS, Philippi.

Syn.—Gadilia, Gray, 1847. Helonyx, Stimpson, 1865. Gadus, Deshayes.

Distr.—2 sp. Norway, Hong Kong. Fossil, numerous; Palæozoic, Jurassic, Cretaceous, etc. *C. subfusiformis*, Sars (cii, 99).

Shell short, more or less inflated in the middle, apical orifice entire, circular, with annular, suboblique internal plica remote from the apex. Terminal pedal disk concave in the middle, marginal tentacles slightly elongated, median tentacles none?

Cadulus differs from Siphonodentalium by the shell being quite smooth, transparent and lustrous, tumid in the middle or anterior portion, and its mouth encircled by a narrow rim.

DISCHIDES, Jeffreys (1867), 1883.

Distr.—*D. bifissus*, Wood. Europe.

Terminal slits bilateral. Animal whitish, gelatinous; mantle rather thick, forming a collar around the front opening of the shell; captacula issuing from within the mantle, numerous, capable of so great an extension as to exceed the shell in length; stalks very slender; terminal bulbs oval; foot cylindrical and narrow, protruded from the middle of the mouth as from a sheath; it is occasionally thrust out in a darting manner and suddenly withdrawn, and so swiftly that the point of the foot could not be observed; the foot is usually curved towards the point; anal tube protruded beyond the narrower end of the shell—it consists of an outer and inner part, the latter being folded to suit the slit on each side; gills rather short, of a brownish color.—JEFFREYS.

Class PELECYPODA.

(*Lamellibranchiata, Conchifera, Bivalves.*)

Acephalous mollusks, or those without a head, are laterally symmetrical, the organs being enclosed in a mantle, one leaf or fold of which envelops each side, and is itself covered and protected by a valve of the bivalve shell—which is always present. They all breathe by means of gills only, and are therefore inhabitants of water, either salt or fresh. The mantle is usually open on the edge, but sometimes its leaves are united more or less, when the mantle is said to be *closed;* it is sometimes tubularly prolonged posteriorly into a siphon. Between the lobes of the mantle lay the gills or branchiæ, two on each side, leaf-like and striate. The most prominent organs of the body are the liver and viscera. The cerebral ganglion is situated above the mouth, and communicates with the other near or distantly situated ganglia. The mouth is at one extremity, the anus at the other; the former is provided with four small, triangular, fleshy leaflets, the extremities of the lips, used partly as tentacles. The heart is in the dorsal region; it has but one ventricle, and the circulation is simple. The foot is a somewhat fleshy mass, atrophied in the adherent species, usually suitable for digging, but rarely very useful for other locomotion. The principal muscles are: (1) those controlling the movements of the foot, which have their insertion upon the valve, partly near the hinge, partly near the adductors, forming pedal scars; (2) the adductor muscles, which, running through the mass of the animal, are inserted upon the middle or sides of each valve, forming adductor scars or impressions. When the adductor muscle is single, it is generally centrally situated, as in the oyster, and such bivalves are termed monomyary; when double, one is at either side of the valve, and such mollusks are termed dimyary. The contraction of these muscles closes the valves; when relaxed, the valves open by reason of an elastic ligament which joins them together at the dorsal or hinge-line.

Mostly diœcious. No sexual union, fertilization being accomplished by the surrounding water containing the male element.

Shell composed of two valves, but with occasionally smaller, supernumerary pieces about the hinge; this latter is either a plain line, or more or less thickened internally, and provided with interlocking teeth and fossets. Some shells, from their shape, cannot be completely closed, or at least portions, front or back, or both, are always gaping.

The form of the shell, number and position of the retractors, scar of the mantle-margin, the hinge, its condition as to teeth,

etc., and position of the hinge-ligament, give some of the principal characters for genera and higher groups; they are, as a rule, and especially for recent shells, rather more satisfactory than the characters used for univalve mollusca.

Order SIPHONIDA. Animal with siphons, and mantle-margin more or less closed.

Order ASIPHONIDA. No siphons; mantle-margins open.

ORDER SIPHONIDA.

Comprises most of the marine bivalve mollusca, including a large portion of the old order Dimyaria—having two well-developed muscular impressions.

Suborder SINUPALLIATA. Siphons long, partly or wholly retractile; the pallial impression upon the inside of the valve having a sinus.

Suborder INTEGRIPALLIATA. Siphons short, not retractile; pallial impression simple, without sinus.

Suborder *SINUPALLIATA.*

(*Pholadacea.*)

FAMILY GASTROCHÆNIDÆ.

Shell equivalve, gaping; valves thin, edentulous, united by a thin, external ligament, sometimes cemented to a shelly tube when adult; adductor impressions 2, pallial line sinuated.

Animal elongated, truncated in front, produced behind into two very long, united, contractile siphons, with cirrated orifices; mantle-margins very thick in front, united, leaving a small opening for the finger-like foot; gills narrow, prolonged into the branchial siphon.

The shell-fish of this family, the Tubicolidæ of Lamarck, are burrowers in mud or stone. They are often gregarious, living in myriads near low-water line, but are extracted from their abodes with difficulty.

SUBFAMILY *ASPERGILLINÆ.*

Shell with both valves imbedded in the walls of a tube, with their umbones visible externally. Base of the tube ornamented with radiated tubuli, containing tentacular processes originating in the animal's mantle.

ASPERGILLUM, Lam., 1818.

Watering-pot shell.

Syn.—Clepsydra, Schum., 1817. Brechites, Guett., 1774. Aquaria, Perry, 1811.

Distr.—21 sp. Red Sea, Java, Australia, New Zealand; in sand. Fossil, 1 sp. (*A? Leognanum*, Hœning. Miocene; Bordeaux.)

Shell small, equilateral, cemented to the lower end of a shelly tube, the umbones alone visible externally; tube elongated, closed below by a perforated disk with a minute central fissure; siphonal end plain or ornamented with ruffles.

Animal elongated; mantle closed, thickened and fringed with filaments in front; foot conical, anterior, opposed to a minute slit in the mantle; palpi lanceolate; gills long, narrow, united posteriorly, continued into and attached to the branchial siphon.

WARNEA, Gray, 1858. The siphonal end of the tube fringed with from one to several rows of ruffles. *A. vaginiferum*, Lam. (civ, 43). Red Sea.

PENICILLUS, Gray, 1858. Disk surrounded by a single fringe of tubuli; valves not surrounded by wavy depressions on the surface of the tube. *A. dichotomum*, Chenu.

CLEPSYDRA, Gray, 1858. Fringe of the disk consisting of two or three series of tubes; valves not surrounded by wavy depressions on the surface of the tube. *A. strangulatum*, Chenu.

FŒGIA, Gray, 1840. Valves not surrounded by wavy depressions; covered more or less by a sunken tubercle in front; disk of the tube fringed. *F. agglutinans*, Lam.

ARYTENE, Gray, 1858. Like Fœgia, but the disk not fringed. *A. Recluzianum*, Chenu.

'HUMPHREYA, Gray, 1858. Tube attached by its base to a shell or stone and much distorted in growth. *H. Strangei*, A. Ad. (civ, 44). Australia.

SUBFAMILY *CLAVAGELLINÆ.*

Shell with the right valve only free, the left being imbedded in the tube; with or without radiated tubuli on the lower end of the tube.

CLAVAGELLA, Lamarck, 1807.

Distr.—6 sp. Mediterranean, Australia, Pacific; 11 fathoms. Fossil, 14 sp. Cretaceous—; Britain, Sicily, Southern India.

Shell oblong, valves flat, often irregular or rudimentary, the left cemented to the side of the burrow, when adult, the right always free; anterior muscular impression small, posterior large, pallial line deeply sinuated. Tube cylindrical, more or less elongated, sometimes divided by a longitudinal partition; furnished with a succession of siphonal fringes above, and terminating below in a disk, with a minute central fissure, and bordered with branching tubuli.

Animal with the mantle closed in front, except a minute slit for the foot, and furnished with tentacular processes; palpi long

and slender; gills 2 on each side, elongated, narrow (floating freely in the branchial siphon ?).

Some specimens of the recent *C. aperta* have 3 frills to their tubes; *C. bacillaris* has twice that number occasionally. They are formed by the siphonal orifices when the animal continues elongating, after having fixed its valve and ceased to burrow; or perhaps, in some instances, when it is compelled to lengthen its tubes upwards by the accumulation of sediment. Brocchi mentions that on breaking the tube of the fossil *C. echinata*, he sometimes found the shell of a Saxicava or Petricola beside the loose valve of the Clavagella, into whose tube they must have entered after its death. *C. elongata* is found in coral; *C. Australis* lives at low tide, and spurts out water when alarmed.

CLAVAGELLA (restricted). Only known in a fossil state, having the lower end of the tube surrounded by hollow spinous processes.

STIRPULINA, Stoliczka. Valves ovate, subequal, similar to those of Clavagella, but tubuli formed only at the front part of the tube which has a distinct fissure; tube long. *Clavagella coronata* or *bacillaris* of Desh. A fossil group only.

BRYOPA, Gray, 1840. (Recent.) Lower end of tube simple; siphonal end frilled. *C. aperta*, Sowb. (civ, 45). Mediterranean Sea.

DACOSTA, Gray, 1840. (Recent.) Lower and siphonal ends of tube both simple. *C. Australis*, Sowb.

SUBFAMILY *GASTROCHÆNINÆ.*

Shell with both valves free from the tube.

GASTROCHÆNA, Spengler, 1780.

Syn.—Chæna, Retz., 1788. Fistulana, Brug., 1789.

Distr.—3 sp. Madagascar, India, Philippines, Australia; burrowing in sand or mud. Fossil. Cretaceous; United States, Europe, Southern India. *G. mumia*, Spengler (cv, 67, 68). Philippines.

Shell elongated, narrow, contained within a shelly tube; posterior adductor nearly central, with a pedal scar in front; siphonal inflection angular, with its apex joining the pallial line. Tube round, straight, tapering upwards, transversely striated, closed at the lower end when complete, and furnished with a perforated diaphragm behind the valves.

Animal elongated, rounded, cephalic extremity swollen; siphons united, long.

ROCELLARIA, Bellevue, 1802.

Syn.—Gastrochæna, Cuv., 1817. Roxellaria, Agassiz.

Distr.—10 sp. West Indies, Britain, Canaries, Mediterranean,

Red Sea, India, Mauritius, Pacific Islands, Galapagos, Panama; 30 fathoms. Fossil, 20 sp. Inf. Oolite—; Europe, United States. *R. hians*, Chemn. (civ, 46). W. Indies.

Shell regular, wedge-shaped, umbones anterior; gaping widely in front, close behind; ligament narrow, external; pallial sinus deep; tube irregular.

Animal with mantle closed, and thickened in front; foot finger-like, grooved, sometimes byssiferous; siphons long, separate only at their extremities; lips simple, palpi sickle-shaped, gills unequal, prolonged freely into the branchial siphon.

R. modiolina perforates shells and limestone; its holes are regular, about two inches deep and a half inch diameter; the external orifice is hour-glass shaped, and lined with a shelly layer which projects slightly. When burrowing in oyster-shells it often passes quite through into the ground below, and then completes its abode by cementing such loose material as it finds into a flask-shaped case, having its neck fixed in the oyster-shell; in some fossil species the siphons were more separated, and the flasks have two diverging necks. The siphonal orifices are rarely four-lobed.

SPENGLERIA, Tryon, 1861. Valves elongate-cuneiform, truncated at the posterior end, with an elevated, transversely lamellated portion radiating from the beaks to the posterior margin. *R. rostrata*, Spengler (civ, 47). West Indies.

CUCURBITULA, Gould, 1861.

Distr.—*C. cymbia*, Spengl. (cv, 69). China.

Shell regular, elongate, equivalve, gaping the whole length, anteriorly enveloped by the mantle of the animal.

Tube very short, ovate or gourd-shaped, composed of successive calcareous layers or cups involving bits of shell or sand. Attached by one side to shells, etc.

FAMILY TEREDIDÆ.

Animal vermiform, its two long siphons furnished at their extremity with each a testaceous pallet; valves gaping, with an interior spoon-shaped process proceeding from the hinge. Animal and valves contained within an irregular calcareous tube, with which it lines its perforations in timber and clay.

TEREDO, Linn., 1757.

Distr.—21 sp. Norway, Britain, Black Sea, Tropics, 119 fathoms. Fossil, 24 sp. Lias—; United States, Europe. *T. navalis*, Linn. (civ, 48); U. S. *T. Norvegica*, Spengler (cv, 70–73).

Shell globular, open in front and behind, lodged at the inner extremity of a burrow partly or entirely lined with shell; valves

three-lobed, concentrically striated, and with one transverse furrow; hinge-margins reflected in front marked by the anterior muscular impressions; umbonal cavity with a long, curved, muscular process.

Animal worm-like; mantle-lobes united, thickened in front, with a minute pedal opening; foot sucker-like, with a foliaceous border; viscera included in the valves, heart not pierced by the intestine; mouth with palpi; gills long, cord-like, extending into the siphonal tube; siphons very long, united nearly to the end, attached at the bifurcation and furnished with two shelly pallets or styles; orifices fringed.

T. navalis is ordinarily a foot long, sometimes two and a half feet; it destroys soft wood rapidly, and teak and oak do not escape; it usually bores in the direction of the grain, unless it meets the tube of another Teredo or a knot in the timber. In 1731–2 it did great damage to the piles in Holland, and caused still more alarm: metal sheathing and broad-headed iron nails have been found most effectual in protecting piers and ship-timbers. The Teredo was first recognized as a bivalve mollusk by Sellius, who wrote an elaborate treatise on the subject in 1733.—FORBES.

T. corniformis, Lamarck, is found burrowing in the husks of cocoa-nuts and other woody fruits floating in the tropical seas; its tubes are extremely crooked and contorted, for want of space. The fossil wood and palm-fruits (*Nipadites*) of Sheppy and Brabant are mined in the same way.

T. Norvegica and *T. nana* are divided longitudinally and also concamerated by numerous, incomplete, transverse partitions at the posterior extremity of the tube.

I annex Dr. J. Gwyn Jeffreys' excellent account of this mollusk:

"The Teredo is an anomaly. It consists of a long and nearly gelatinous worm-like body, without rings or segments, terminating at one end in a pair of hemispherical valves, that somewhat resemble the two halves of a split nutshell which has had a large slice cut off at each side, and at the other end in a pair of symmetrical shelly paddles with handles of different lengths, which close this extremity at the will of the animal. The open part of the bivalve shell is placed at the further end, and receives a circular disk, of a fleshy or rather muscular nature, which may be termed the foot; this is the broadest or widest part. Inside each valve is seen a curved process, like a bill-hook, that projects from the hinge at a right-angle. The shell covers and protects the mouth, palps, liver and other delicate organs. The body tapers gradually to the outer or nearer end, where it becomes quite small and attenuated; it contains the gullet, intestines and gills, and is enveloped in a thin membrane or mantle, which forms at the outer end two cylindrical

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tubes (siphons), mostly of unequal length. The larger tube (siphon) takes in infusoria or similar animalcules, which constitute the food of the Teredo, as well as imbibes water charged with air for the purpose of respiration and keeping the whole fabric moist; while the smaller tube is employed to eject the water which has been exhausted or deprived of its aeriferous qualities, and also serves to get rid of the woody pulp that is excavated by the Teredo. Both tubes form a kind of hydraulic machine. At the base of each lies one of the paddles, often termed 'pallets,' and which may be translated into scientific language as 'claustra.' When the Teredo is alarmed or not feeding, it withdraws its tubes into the neck of its sheath or shelly cylinder; and the pallets, which had been previously kept pressed against the sides, then spring forward and close the opening, so as to form an efficient barrier against all foes, whether crustacea or annelids. This complicated animal mechanism is entirely enclosed in the sheath or cylinder above mentioned, which is secreted by the mantle, and varies considerably in thickness and extent. The inside of the sheath is, at its outer or narrower end, divided into short strips or ledges, arranged in an imbricated fashion; the last-formed of these ledges serves as a *point d'appui* for the blades of the paddles, and it greatly assists the Teredo in closely shutting its doors. The whole of what I have above endeavored to describe is found only within some hard vegetable substance, either the hull of a vessel or boat, a harbor pile, a shipping-stage, a floating tree or the roots of one growing on the banks of an estuarine river. The food of the Teredo consists entirely of minute organisms, that are introduced with the water into the incurrent or branchial tube, and it does not consume the wood as any part of its nourishment. Nor do I believe that the eroded material undergoes any chemical change, either in the stomach of the Teredo or in the passage outwards through the intestine, although in the latter receptacle it is closely compressed. When it is voided or expelled by the excurrent tube, and separated in the water, it becomes a flocculent mass of pulp, like that of paper, composed of extremely minute and fine particles of an irregular size and shape, but still retaining its fibrous structure. It does not exhibit any appearance of having been digested."

CALOBATES, Gould, 1862. Siphonal pallets large, long, stilt-shaped, siphons adherent, only becoming free at the tips. *T. furcelloides*, Gray. 2 sp. Burmack, Australia.

NAUSITORA, Wright, 1864. Siphonal pallets, outer surface convex, covered with thick scale-like striæ, inner flat or slightly concave. *N. Dunlopi* (fresh-water, India). 2 sp. Burrowing in wood. Bengal, Australia.

LYRODUS, Gould. This name is given for a small American

species, *T. chlorotica*, the pallets of which are elongated, with the basal portion, thin, flexuous, the upper lyre-shaped, the extreme two-thirds of their length being covered with a dark crust which has a projecting horn at each angle. The form of these pallets very closely resembles that of Nausitoria, when the tip is broken away; it may belong to the same genus.

? TEREDOLITES, Desh. For a cretaceous species, *T. clavatus*, only known by some tubes which are short, clavate, and in position, as they occur in the rock or wood, almost parallel to each other.

[POLORTHUS, Gabb. See page 53, vol. ii.]

XYLOTRYA, Leach, Gray, 1847.

Syn.—Bankia, Gray.

Distr.—10 or 12 sp. Universal. *X. palmulata*, Lam. (cv, 74). E. Indies.

Siphonal pallets elongated and penniform, the blade consisting of articulated pieces radiating obliquely from the style. A species occurs in the fossil wood of the Greensand of Blackdown, England.

UPEROTIS, Guettard.

Syn.—Guettera, Gray.

Distr.—*U. clava*, Gmel. (civ, 49). Tranquebar.

Tube club-shaped, straight or contorted, growing together in masses; pallets oval, jagged; valves narrow and elongated.

KUPHUS, Guettard.

Syn.—Furcella and Septaria, Lam. Clauseria, Menke.

Distr.—*K. arenarius*, Linn. (civ, 50–52). Philippines.

Tube penetrating sand, somewhat irregular, very large; pierced around the base with small scattered perforations, and inclosed by two overlapping convex septa arising from the sides and completely closing the end. These septa appear to replace the valves.

The tube of the giant Teredo is often two yards long and two inches in its greatest diameter; when broken across it presents a radiating prismatic structure. The siphonal end is divided lengthwise, and sometimes prolonged into two diverging tubes.

TEREDINA, Lam., 1818.

Distr.—*T. personata*, Lam. (civ, 53, 54). Eocene; Europe.

Valves with an accessory plate in front of the umbones; free when young, in the adult connected with the tube. The tube is sometimes concamerated; its siphonal end is often truncated; and the opening contracted by a lining which makes it hour-glass shaped, or six-lobed.

The possession of an accessory dorsal valve connects this genus with the next family; no siphonal pallets have been discovered.

Family PHOLADIDÆ.

Shell gaping at both ends; thin, white, brittle, and exceedingly hard; armed in front with rasp-like imbrications; without hinge or ligament, but often strengthened externally by accessory valves; hinge-plate reflected over the umbones, and a long curved muscular process beneath each; anterior muscular impression on the hinge-plate; pallial sinus very deep.

Animal club-shaped; foot short and truncated; mantle closed in front, except the pedal orifice; siphons large, elongated, united nearly to their ends; orifices fringed; gills narrow, prolonged into the exhalent siphon, attached throughout, closing the branchial chamber; palpi long.

The cartilage of the hinge in these shells is small and internal; the ligament is strong and elastic, situated externally, and both are further strengthened by an accessory membrane formed by the coriaceous end of the mantle, which issues between the anterior ends of the valves and covers the ligament; this extension of the mantle is fixed by filaments which enter the dorsal cells and is furnished usually with calcareous plates which maintain the valves in position.

The Pholadidæ perforate rocks, wood or clay; the burrows are vertical, quite symmetrical, and seldom in contact.

Subfamily *PHOLADINÆ*.

Valves with an anterior gap which is never closed in the adult shells.

Pholas, Linn., 1757.

Etym.—*Pholas*, a burrowing shell-fish, from *pholeo*, to bore. Piddock.

Syn.—Hypogæa and Hypogæoderma, Poli.

Distr.—*P. costata*, Linn. (civ, 55–57). U. S. Fossil; Jurassic, Cretaceous, Tertiary.

Shell elongated, cylindrical; dorsal margin protected by two accessory valves; anterior and posterior in position; umbonal processes reflexed over the beaks, closely applied. Pallial sinus reaching the centre of the shell.

Animal with a large truncated foot, filling the pedal opening; body with a fin-like termination; combined siphons large, cylindrical, with fringed orifices. *P. costata* is sold in the market of Havana, where it is an article of food.

Mr. W. Woods remarks that on the coast of Normandy the Pholads are eaten in abundance, well seasoned and cooked with fine bread-crumbs and herbs. They are also reckoned a delicacy when pickled in vinegar. In the neighborhood of Dieppe a great many women and children, each provided with an iron

pick, are employed in collecting them, either to sell in the market, or for fishermen's bait. They are almost entirely littoral,

"Entomb'd upon the very hem o' the sea."

The property which they possess of shining in the dark is very remarkable.

CYRTOPLEURA, Tryon, 1862. Margins of the valves emarginate anteriorly, forming a short, wide hiatus. 3 sp. U. S., Panama, Philippines.

DACTYLINA, Gray, 1847.

Distr.—3 sp. *D. dactylus*, L. (civ, 58, 59). Europe.

Shell oblong-oval, anteriorly emarginate; cardinal margin reflected over the back of the shell, from which it is separated by numerous horizontal plates, covered by two dorsal accessory valves, arranged side by side, their nuclei at their outer margins, posterior to the centre.

Siphons naked to the base; orifice of the branchial siphon cirrated, that of the anal siphon simple or crenulated.

The common piddock is used for bait on the Devon coast (England); its foot is white and translucent when fresh, like a piece of ice; the hyaline stylet lodged in it is large and curious.

GITOCENTRUM, Tryon, 1862. Valves not emarginate anteriorly, but regularly rounded, forming a long, narrow hiatus; nuclei of the dorsal valves anterior, situated nearer the inner margin. 2 sp. Southern U. S., W. Indies, Chili. *D. campechensis*, Gmel.

BARNEA (Leach), Risso, 1826.

Distr.—9 sp. Australia, Burmah, Red Sea, Europe, Patagonia, Philippines. *B. candida*, Linn. Europe.

Shell oval-oblong; anteriorly gaping; a single lanceolate dorsal accessory valve; umbonal process reflexed, closely applied.

BARNEA (typical). Anterior margins regularly rounded, forming a long, narrow hiatus.

ANCHOMASA, Leach. Ventral anterior margin of the valves emarginate, the hiatus short and wide. *B. parva*, Pennant. Europe.

MONOTHYRA, Tryon, 1862.

Distr.—*M. orientalis*, Gmel. (civ, 60). India.

Dorsal valve ovate-cuneiform; reflexed umbonal processes cellular beneath.

XYLOPHAGA, Turton, 1822.

Etym.—*Xulon*, wood, *phago*, to eat.

Distr.—3 sp. Norway, Britain, Western South America, Mergive Is. Bores an inch deep, and across the grain, in floating wood, and timbers which are always covered by the sea. A few tertiary species. *X. dorsalis*, Turton (cv, 77–79). England.

Shell globular, with a transverse furrow; gaping in front,

closed behind; pedal processes short and curved; anterior margins reflected, covered by two small accessory valves; burrow oval, lined with shell.

Animal included within the valves, except the slender contractile siphons, which are furnished with pectinated ridges, and divided at the end; foot thick, very extensile.

TURNUS, Gabb.

Distr.—Cretaceous; California, India. *T. plenus*, Gabb.

Shell like that of Xylophaga, but has posterior to the internal umbonal rib another, often broader rib, running from behind the apex to the infero-posterior margin.

The animal also secretes a shelly tube, and consequently the valves must have been much more gaping posteriorly than they are in the recent Xylophagæ, which only slightly protrude out of their shells. The accessory valves are unknown, and it is therefore difficult to classify exactly the genus, for it may be just as possible that it is a form of the Teredininæ.

TURNUS, Gabb. (Typical.) Shell transversely oval; anterior hiatus formed by the oblique truncation and slightly sinuous outline of the anterior ventral margins of the valves; umbonal sulcus and both of the internal ridges very oblique, narrow, smooth, and extending to the free margins. *T. plenus*, Gabb.

GONIOCHASMA, Meek. Shell transversely ovate-oblong; hiatus formed by a deep rectangular notch in the anterior ventral margins; umbonal sulcus and corresponding internal ridge slightly oblique, and the latter finely and obscurely crenate; posterior internal ridge broad, deep, very oblique, smooth; and not extending to the free margins. *G. Stimpsoni*, M. and H.

XYLOPHAGELLA, Meek. Shell globose; anterior hiatus formed by a large, deep, rectangular notch in the anterior ventral margins; umbonal sulcus and corresponding internal ridge descending vertically, the latter being strongly crenate by little projecting points; posterior internal ridge as in the last, excepting that it is less oblique and placed in front of the posterior umbonal slopes. *X. elegantula*, M. and H. (cv, 76).

ZIRPHÆA, Leach, 1851.

Distr.—3 sp. Europe, U. S., Senegal, Straits of Sunda. *Z. crispata*, Linn. (civ, 61).

Shell oval, cardinal margin scarcely reflected; no accessory valves, the beaks protected by a membrane; usually a thin, fugacious epidermis; anteriorly greatly gaping.

TALONA, Gray, 1847.

Distr.—*T. explanata*, Spengler (civ, 62; cv, 84). W. Africa.

Shell narrowly gaping anteriorly; two accessory dorsal plates,

lateral and divergent. Base of siphons protected by corneous or calcareous sheaths.

NAVEA, Gray, 1851.

Distr.—3 sp. California. *N. subglobosa*, Gray (cv, 80, 81).

Shell oval, widely gaping anteriorly, close posteriorly; surface divided by a subcentral groove; dorsally covered by a coriaceous epidermis (striated behind the interior spatulate processes), under which is a small transverse posterior dorsal valve.

SUBFAMILY *JOUANNETINÆ.*

Anterior ventral gap closed in the adult by a callous plate.

PHOLADIDEA, Turton, 1819.

Syn.—Cadmusia, Leach.

Distr.—8 sp. W. Coast of N. America, New Zealand. *P. papyracea*, Sol. (cv, 82, 83).

Shell globose-oblong, with a transverse furrow; anterior gap large, closed in the adult by a callous plate; two minute accessory valves in front of the beaks.

Animal with a fringed disk at the end of the combined siphons, and a horny cup at their base (in adults).

HATASIA, Gray, 1851. Siphonal cups or valves with a tubular shelly prolongation. *P. melanura*, Sowb.

TALONELLA, Gray, 1851. Siphonal valves without any tubular prolongation, and with a longitudinal and transverse fold. *P. tridens*, Gray.

NETASTOMELLA, Carp. Based upon *Ph. Darwinii*, Sowb., 1865. The valves are posteriorly prolonged into a flattened calcareous cup. Differs from Jouannetia in having both valves equal, and from Pholadidea by the calcareous nature of the cup at the posterior end of the shell.

JOUANNETIA, Desmoulins, 1828.

Syn.—Triumphalia, Sowb., 1849.

Distr.—2 sp. Philippines.

Shell very short, subglobose, with two impressed radiating grooves; right valve longest behind; anterior opening closed by a callous plate developed from the left valve overlapping the margin of the right valve, and fixed to the single unsymmetrical umbonal plate.

PHOLADOPSIS, Conrad, 1849. Valves with a single subcentral radiating groove. *J. pectinata*, Conr. (civ, 63). California.

PARAPHOLAS, Conrad, 1848.

Distr.—2 sp. California, Australia. Fossil; Cretaceous. *P. Californica*, Conr. (civ, 64).

Shell oval-oblong; anterior gap closed by a thin, swollen, glo-

bose callous plate; valves equal, divided by two radiating grooves into three portions; two dorsal valves.

PENITELLA (Valenciennes), Conrad, 1849.

Distr.—*P. penita*, Conr. (civ, 65). California.

Anterior dorsal plates two, placed side by side, posterior to which is a central plate directly over the umbones; base of the siphons protected by reflected appendages.

MARTESIA, Leach, 1847.

Distr.—13 sp. World-wide. Fossil; Cretaceous and Tertiary. *M. striata*, Linn. (civ, 66).

Valves lengthened behind when full-grown, by a plain border; umbonal valves one or two, dorsal and ventral margins often with narrow accessory valves; surface impressed with one or more furrows. *M. striata* burrows in hard timber. *M. teredin-iformis* was found in cakes of floating wax on the coast of Cuba. (G. B. Sby.) *M. Australis* in (fossil ?) resin, on the coast of Australia. *M. rivicola* in timber twelve miles from the sea, in Borneo (fresh-water). *M. scutata*, Eocene, Paris, lines its burrow with shell.

MARTESIA (restricted). One accessory dorsal plate.

DIPLOTHYRA, Tryon, 1862. Shell with a double accessory valve; the principal plate directly over the umbones, with a smaller anterior one adjoining. *M. Smithii*, Tryon. Staten Island, N. Y., and Chesapeake Bay, burrowing in oyster-shells.

PHOLAMERIA, Conrad, 1865. The shell has the form of a short Martesia, but without accessory plates; nothing else, however, occurs in the specific description which would indicate any peculiarity to justify the formation of a new genus. *M. triquetra*, Conr. Tert.; U. S.

SCHRÖTERIA, Tryon, 1862. Has one preumbonal plate; the anterior hiatus is probably closed. *M. cordata*, Schröter.

(*Solenacea.*)

FAMILY SOLENIDÆ.

Shell elongated, gaping at the ends; ligament external; hinge-teeth usually 2·3, compressed, the posterior bifid. External shell layer with definite cell-structure, consisting of long prisms, very oblique to the surface, and exhibiting nuclei; inner layer nearly homogeneous.

Animal with a very large and powerful foot, more or less cylindrical; siphons short and united (in the typical Solens, with long shells) or longer and partly separate (in the shorter and more compressed genera); gills narrow, prolonged into the branchial siphon.

SUBFAMILY *SOLENINÆ.*

Siphons short and united, foot more or less cylindrical and obtuse. Shell elongated, transverse, truncate at both extremities; hinge nearly terminal, usually with a single tooth in each valve; pallial line profoundly sinuated and truncated.

SOLEN, Linn., 1757.

Etym.—Razor-shell.

Syn.—Hypogæa and Hypogæoderma, Poli.

Distr.—37 sp. World-wide, except Arctic seas; 100 fathoms. Fossil, 40 sp. ? Silur., Carb.—; United States, Europe. *S. vagina*, Linn. (cvi, 6).

Shell very long, subcylindrical, straight, margins parallel, ends gaping; beaks terminal, or subcentral; hinge-teeth, one in each valve; ligament long, external; anterior muscular impression elongated; posterior oblong; pallial line extending beyond the adductors; sinus short and square.

Animal with the mantle closed except at the front end, and a minute ventral opening; siphons short, united, fringed; palpi broadly triangular; foot cylindrical, obtuse.

In this genus the mantle is produced behind into a truncate siphonal sheath which contains the two short siphons which are never extended beyond the shell. The animal has the power of changing the terminal portion of the foot from a tapering point to an obtuse club. By suddenly extending the foot it is enabled to ascend rapidly the deep burrow it forms in the sand.

The annexed additional account of the Solen is from "British Conchology," by Dr. J. Gwyn Jeffreys:

"The razor-fishes (or 'spout-fishes,' as they were called by Grew and other naturalists of former days) usually burrow in the sand at the verge of low-water mark, not perpendicularly, but in a slanting direction at an angle of about 60 degrees. On the retreat of spring-tides, they may be seen nearly half out of their holes, apparently taking in a supply of oxygen for their gills. They are evidently sensible of vibratory movements in the air, as well as on ground, taking alarm at greater or less distances according to the state of the atmosphere and direction of the wind. When the Solen is disturbed it squirts out water in a strong jet; and having thus compressed the volume of its body, it lengthens and darts out its dibble-shaped foot, and rapidly disappears below the surface to a depth of two or three feet. A Solen-hunt requires considerable alertness; for if you cannot approach near enough to catch them when partly exposed to view—and this is not easy, their muscular strength being, in proportion to their size, far greater than that of man—and you delve with your hands after them, they will probably beat you in the race. The stake is much more important to them than to

you, and it calls for all their energies. Fishermen entice them out of their holes by a pinch of salt, making (as they say) the razor-fish believe that the tide is coming in. Reaumur, however, considers that the salt irritates them, and causes a painful pricking sensation in the mantle, which induces them to rise to the surface and endeavor to get rid of the annoyance by expelling the salt backwards. He also noticed the blind instinct which the Solen has when taken out of its hole, and held between the fingers in the open air, suspended vertically: it protrudes its foot several times in succession, as if it were in the act of burrowing into its native sands. The account given by Poli of Solen-fishing in Naples is curious. We know that the flow and ebb of the tide there are very slight, and different from what takes place on our own British shores. He tells us that the lurking-place of the Solen is betrayed by a hole in the sand, agreeing in shape with the apertures of its tubes or siphons. Where the water is shallow the fisherman sprinkles some oil on the surface, in order to see these marks more clearly. He then steadies himself by leaning on a staff with his left hand, and feels for the Solen with his naked right foot. This he catches and holds between his big toe and the next; but although his toes are protected by linen bands, the struggles of the Solen to escape are so violent, and the edges of the shell so sharp, that very often a severe wound is inflicted by it. When the sea is five or six feet deep, another mode of fishing is adopted. It consists in the fisherman diving or swimming under water with his eyes open, and, after having found the holes, digging with his hands for the razor-fish. Sometimes the Solen so forcibly resists being taken, that it will suffer its own foot to be torn away, or will even die rather than surrender. Their power of locomotion is not limited to burrowing; they can dart from place to place in the water as quickly as a scollop, and apparently in the same way."

SOLENA, Brown, 1756. (Hypogella, Gray. Plectosolen, Conr.) Shell rounded at each extremity; hinge nearly terminal; anterior muscular impression rounded. Scarcely distinguishable from the typical group. 3 sp. Cuba, Philippines, Panama. *S. obliqua*, Spengler (cvi, 7).

ENSIS, Schumacher, 1817.

Syn.—Ensatella, Swains., 1840.

Distr.—14 sp. U. S., Europe, Patagonia, Philippines, Australia. *E. ensis*, Linn. (cvi, 8). *E. siliqua*, Linn. (cvi, 9).

Shell elongated, transverse, gaping and rounded-truncate at its extremities, straight or somewhat curved; hinge composed of two teeth in one valve and three in the other; anterior muscular impression elongated, horizontal; pallial impression with a short truncated sinus; siphons short, divided.

SOLENOPSIS, M'Coy, 1844.

Distr.—*S. minor*, M'Coy (cv, 85). Carboniferous; Ireland.

Shell like Solen, but somewhat thicker anteriorly, and with inflated beaks; posterior end truncate.

This genus has been proposed for the reception of some palæozoic species, formerly described as Solen, like *S. pelagicus* and *vetustus* of Goldfuss, *S. siliquoides*, Kon., and others. The general form of these shells is very much like that of elongated species of Sphenia; the hinge-teeth, if any, are not as yet known, and it is therefore, strictly speaking, impossible to classify the genus correctly; D'Orbigny identifies it with Lyonsia.

SOLENARIA, Stoliczka, 1870.

Distr.—*S. affinis*, Eichw. Turonian; Russia.

Shell thin, narrow, long and straight, like a Solen, internally with two radiating, diverging ribs, originating at the beaks and proceeding towards the ventral edge. The hinge is as yet unknown, but the general form of the shell agrees entirely with Solen.

CULTELLUS, Schumacher, 1817.

Etym.—*Cultellus*, a knife.

Distr.—12 sp. Africa, India, Nicobar, Philippines. Fossil; Tertiary. *C. cultellus*, Linn. (cvi, 10, 11).

Shell elongated, compressed, rounded and gaping at the ends; hinge-teeth 2·3; beaks in front of the centre, supported internally by an oblique rib; pedal impression behind the umbonal rib; posterior adductor trigonal; pallial line not prolonged behind the posterior adductor; sinus short and square.

Animal (of *C. Javanicus*) with short, fringed siphons; gills narrow, half as long as the shell, transversely plaited; palpi large, angular, broadly attached; foot large, abruptly truncated.

ENSICULUS, H. and A. Ad. Proposed for the old *Solen cultellus*, Linn., differing from the other species of Cultellus by its more elongated, curved and parallel form, and the short, oblique ribs below the umbones.

SUBFAMILY *PHARELLINÆ.*

Siphons elongated, separated for half their length. Shell transverse, elongated, gaping and rounded at the extremities; umbones subcentral, instead of terminal as in Soleninæ; hinge-teeth varying, usually three in one valve, two in the other; pallial impression with a profound, rounded sinus.

PHARELLA, Gray, 1854.

Distr.—4 sp. India, East Indies. Fossil. Cretaceous; India, N. America. *P. Javanica*, Lam. (cv, 86).

Shell subcylindrical, transversely elongated, rounded and gaping at the extremities; beaks anterior to the centre; anterior muscular impression elongated, subtrigonal; pallial impression with a small sinus.

Siphons shortly produced and separate; foot large, abruptly truncate. Inhabits the muddy estuaries of rivers.

CERATISOLEN, Forbes.

Syn.—Pharus, Leach, teste Gray, 1840. Polia, d'Orbigny. Solecurtoides, Desm.

Distr.—2 sp. Britain, Mediterranean, Senegal, Red Sea, Singapore. Fossil, 3 sp. Miocene; Italy. *C. legumen*, Linn. (cvi, 12).

Shell narrow, subequilateral, anterior adductor impressions elongated, a second pedal scar near the pallial sinus.

Animal with a long, truncated foot; siphons separate, diverging, fringed.

LEGUMENAIA, Conrad, 1858.

Distr.—*L. elliptica*, Conr. (cvi, 14). Cret.; U. S.

Valves very inequilateral; hinge with two very slender teeth in the right valve under the beak, and one posterior, very oblique, prominent, lamelliform tooth. This group was proposed for a cretaceous species; the form of the teeth and their position agrees with Novaculina, but the posterior tooth is not lamelliform in this genus. A character of further importance is stated to be the shortness of the posterior part of the shell, which is not seen in any of the European or Indian cretaceous species; it does, however, occur in some of the recent American species of Tagelus, from which Legumenaia would differ by its dentition, but externally it would seem impossible to distinguish between both of them.

LEPTOSOLEN, Conrad, 1867.

Distr.—*L. biplicata*, Conr. Cretaceous; U. S.

Elongated, thin in substance, straight, with the dorsal and ventral margins parallel; plicated anteriorly, open at both ends; beaks not nearly terminal; hinge of the right valve with one direct tooth, convex anteriorly, truncated behind; an internal, rounded, direct rib commences under the cardinal margin, gradually becomes less prominent, and disappears towards the ventral margin.

If the existence of a single tooth in the right valve can be considered as a permanent, distinctive character, the separation from Siliqua would have good grounds. The tooth is said to be broadest at the hinge-plate, and tapers to a very acute edge, which is expanded in the direction of the shell's diameter. This peculiarity in the form of the principal or cardinal tooth is often

seen in species of Tagelus. Externally the type species resembles the recent *Pharella Javanica.*

SILIQUA, Muhlfeldt, 1811.

Syn.—Leguminaria, Schum., 1817. Machæra, Gld., 1841. Aulus, Oken., 1815.

Distr.—20 sp. India, China, Ochotsk, Oregon, Sitka, Behring's Sea, Newfoundland, Atlantic United States. *M. costata*, Say, is often obtained from the maw of cod-fish. Fossil, 4 sp. Upper Greensand—; Britain, France. *S. radiata*, Linn. (cvi, 13).

Shell smooth, oblong; epidermis polished; an umbonal rib extending across the interior of the valve; pallial sinus short.

The animal is similar to Solecurtus.

PROTHYRIS, Meek, 1869.

Distr.—2 sp. Carb.; U. S. *P. Meeki*, Winchell (cv, 90).

Shell equivalve, very inequilateral, longitudinally oblong; valves compressed or moderately convex; nearly closed or a little gaping behind, and more or less widely gaping in front, where the hiatus is increased in size by a nearly rectangular notch in the margin, mainly below the middle; beaks depressed and very near the anterior end, with a small ridge usually extending from the anterior side of each to the corner of the anterior marginal notch; dorsal margin without escutcheon or lunule, being erect and sharp behind the beak; surface merely marked with striæ of growth. Hinge and interior unknown.

SOLECURTUS, Blainv., 1824.

Syn.—Solenocurtus, Sowb., 1839. Tagelus, Gray, 1847. Siliquaria, Schum., 1817.

Distr.—11 sp. E. and W. Coasts of N. and S. America, Senegal, Mediterranean. Fossil, 30 sp. Neocomian—; United States, Europe. *S. Dombei*, Lam. (cv, 87).

Shell elongated, rather ventricose, with subcentral beaks; margins subparallel; ends truncated, gaping; ligament prominent; hinge-teeth two in each valve; pallial sinus very deep, rounded; posterior adductor rounded.

Animal very large and thick, not entirely retractile within the shell; mantle closed below; pedal orifice and foot large; palpi triangular, narrow, lamellated inside; gills long and narrow, outer much the shortest; siphons separate at the ends, united and forming a thick mass at their bases; anal orifices plain, branchial fringed.

The Solecurti bury deeply in sand or mud, usually beyond low-water, and are difficult to obtain alive. *P. Caribæus* occurs in countless myriads in the bars of American rivers, and on the coast of New Jersey in sand exposed at low-water; by removing three or four inches of sand its burrows may be discovered;

they are vertical cylindrical cavities, one and one-half inches in diameter and twelve or more deep; the animal holds fast by the expanded end of its foot.

MESOPLEURA, Conrad, 1867. Valves with an interior rib crossing from the beak to the opposite margin. 3 sp. U. S., Java, California. *S. centralis*, Say. Atlantic Coast of U. S.

NOVACULINA, Benson. (Loncosilla, Raf.) Shell oblong, plain; epidermis thick and dull; pallial sinus rather small; anterior pedal scar linear. 3 sp. India, China. In the mud of river-estuaries. *N. constricta*, Lam. (cv, 88).

SOLYMA, Conrad. Shell ovately elongated, thin, equilateral, ventricose; right valve with two direct approximate teeth under the beak. Type, *S. lineolatus* (cv, 89). Cretaceous; N. J. Conrad states that the genus is allied to Leptosolen, though as to form it rather appears to exhibit greater relation to some Tellinidæ, and as regards the hinge-teeth of the right valve it is allied to Solecurtus.

MACHA, Oken, 1815.

Syn.—Solecurtus, Blainv. (pt.). Psammosolen, Risso. Cyrtosolen, Herrm.

Distr.—8 sp. West Indies, Mediterranean, East Indies. *M. strigillata*, Linn. (cvi, 15).

Shell transversely oblong, compressed, rounded and gaping at the extremities, obliquely striate, more or less invested with an epidermis, beaks subcentral, margins nearly parallel; hinge with two diverging primary teeth in each valve; ligament prominent; anterior muscular impression lobed; pallial impression deeply sinuated.

Siphons very large, united at the base; the branchial orifice fringed, anal free. The animal is very large and not entirely retractile within the shell. Usually lives buried in sand, coralline zone.

AZOR, Gray, 1847. Valves smooth, covered by an epidermis. 5 sp. Europe, Philippines. *M. coarctata*, Gmel. (cvi, 16).

(*Myacea.*)

FAMILY SAXICAVIDÆ.

Shell equivalve, thick, gaping at the extremities; hinge with a single cardinal tooth; ligament external, prominent, solid; inserted in a nymphal callosity; pallial impression irregular, sinuous.

Animal elongated, symmetrical; mantle-lobes united, with a small opening for the digitiform foot; siphons large, elongated, covered with a thick skin, the orifices fringed. The Saxicavidæ live in sand, mud or soft rock, excavating the latter. There are but few living species, but the extinct forms are numerous.

SAXICAVA, Bellevue, 1802.

Etym.—*Saxum*, stone; *cavo*, to excavate.

Syn.—Byssomya, Cuv., 1817. Rhomboides, Bl. Hiatella, (*minuta*), Daud., 1799. Biapholius, Leach. Arcinella (*carinata*), Phil. Clotho, Faujas Saint-Fond, 1807.

Distr.—12 sp. Universal. Fossil; Jurassic, Cret. ? Tert.—.

Shell when young symmetrical, with two minute teeth in each valve; adult rugose, toothless; oblong, equivalve, gaping, ligament external; pallial line sinuated, not continuous.

Animal with mantle-lobes united and thickened in front; siphons large, united nearly to their ends, orifices fringed; pedal opening small, foot finger-like, with a byssal groove; palpi small, free; gills narrow, unequal, united behind and prolonged into the branchial siphon.

Five genera and fifteen species have been manufactured out of varieties and conditions of the Protean *S. rugosa*, Linn. (cv, 91, 92). It is found in crevices of rocks and corals, and amongst the roots of sea-weed, or burrowing in limestone and shells; at Harwich (England) it bores in the cement stone (clay iron-stone), at Folkestone in the Kentishrag, and the Portland stone employed in the Plymouth Breakwater has been much wasted by it. Its crypts are sometimes six inches deep (Couch); they are not quite symmetrical, and like those of the Lithodomus, are inclined at various angles, so as to invade one another, the last comers cutting quite through their neighbors; they are usually fixed by the byssus to a small projection from the side of the cell. The Saxicava ranges from low-water to 140 fathoms; it is found in the Arctic seas, where it attains its largest size; in the Mediterranean, at the Canaries, and the Cape. It occurs fossil in the Miocene tertiary of Europe and in the United States, and in all the glacial deposits.

Sometimes they do considerable damage to sea-walls. In the young state, *Saxicava rugósa* gapes at the superior margin, and the hinge is composed of a small tooth in the right valve, and two rather larger oblique teeth in the left valve; in this condition it is the Hiatella of Daudin, and the *Arcínella carínata* of Philippi.

"Successive generations will occupy the same hole. The last inhabits the space between the valves of its predecessor. In this way four or five pairs of shells may be frequently seen nested one within the other, and not unusually a *Sphenia Binghami* in the centre of all. Cailliaud observed a Saxicava within a specimen of *Venerupis Irus*, which it had perforated."—JEFFREYS, *Brit. Conch.*

PARAMYA, Conrad, 1860. (Myalina, Conrad, 1838, not Koninck.) Shell subovate, inequilateral, ventricose over the umbonal slope, slightly flattened from beak to base; surface with irregular

concentric lines; ligament and basal margins straight, parallel; a spoon-shaped fosset in each valve, the lateral margins of which are carinated, and the base emarginated. *S. subovata*, Conr. Miocene; Virginia.

PANOPÆA, Menard de la Groye, 1807.

Etym.—*Panopè*, a Nereid. *Syn.*—Glycimeris, H. and A. Ad.

Distr.—11 sp. Northern seas, Mediterranean, Cape, Australia, New Zealand, Patagonia. Low-water—ninety fathoms. Fossil, 140 sp. Inferior Oolite—; United States, Europe, India.

Shell equivalve, thick, oblong, gaping at each end; ligament external, on prominent ridges; one prominent tooth in each valve; pallial sinus deep.

Animal with very long, united siphons, invested with thick, wrinkled epidermis; pedal orifice small, foot short, thick, and grooved below; gills long and narrow, extending far into the branchial siphon, the outer pair much narrower than the inner, faintly pectinated; palpi long, pointed, and striated.

In *P. Norvegica* the pallial line is broken up into a few scattered spots, as in Saxicava; the animal itself is like a gigantic Saxicava. This species ranges from Ochotsk to the White Sea, Norway, and North Britain; it was formerly an inhabitant of the Mediterranean, where it now occurs fossil. (= *P. Bivonæ*, Philippi.) The British specimens have been caught, accidentally, by the deep-water fishing-hooks. *P. Natalensis* is found at Port Natal, buried in the sand at low-water; the projecting siphons first attracted attention (doubtless by the strong jets of water they sent up when molested), but the shells were only obtained by digging to the depth of several feet. The Mediterranean species *P. glycimeris*, attains a length of six or eight inches.

GLYCIMERIS, Klein, 1753. (Panopæa, H. and A. Adams. Panomya, Gray.) Pallial line broken up into punctations, posterior impression much lengthened. Recent, miocene and pliocene. *P. glycimeris*, Born (cvii, 29–31).

CYRTODARIA, Daudin, 1799.

Syn.—Glycimeris, Lam., 1801.

Distr.—2 sp. Arctic seas, Cape Parry, Northwestern America, Newfoundland. Fossil. Pliocene—; Britain, Belgium. *C. siliqua*, Chemn. (cvi, 17; cvii, 32).

Shell oblong, gaping at each end; posterior side shortest; ligament large and prominent; hinge thick, without teeth; epidermis black, extending beyond the margins; anterior muscular scar long, pallial impression irregular, slightly sinuated.

Animal larger than its shell, subcylindrical; mantle closed, siphons united, protected by a thick envelope; orifices small; pedal opening small, anterior; foot conical; palpi large, striated inside, the posterior border plain; gills large, extending into the branchial siphon.

Family MYACIDÆ.

Shell thick, strong and opaque; left valve with a spatulate cartilage-process, gaping posteriorly; pallial line sinuated; epidermis wrinkled. Structure more or less distinctly cellular, with dark nuclei near the outer surface; cartilage-process composed of radiated cells.

Animal with the mantle almost entirely closed; pedal aperture and foot small; siphons united, partly or wholly retractile; branchiæ two on each side, elongated.

Mya, Linn., 1758.

Etym.—*Myax* (-acis), a mussel (Pliny). Gaper.

Distr.—3 sp. Northern seas. Fossil, 17 sp. Pliocene—; United States, Britain, Sicily,

Shell oblong, inequivalve, gaping at the ends; left valve smallest, with a large flattened cartilage-process; pallial sinus large. Most of the fossil "Myas" have an external ligament, and are related either to Panopæa or Pholadomya.

Animal with a small straight linguiform foot; siphons combined, covered with epidermis, partially retractile; orifices fringed, the branchial opening with an inner series of large tentacular filaments; gills not prolonged into the siphon; palpi elongated, free.

The Myas frequent soft bottoms, especially the sandy and gravelly mud of river-mouths; they range from low-water to 25 fathoms, rarely to 100 or 145 fathoms. *M. arenaria* (cvi, 19, 20) burrows a foot deep; this species and *M. truncata* (cvi, 18) are found throughout the northern and Arctic seas, from Ochotsk and Sitka to the Russian Icy-sea, the Baltic, British coast and northern United States; in the Mediterranean they are only found fossil. They are eaten in Zetland and North America, and are excellent articles of food. In Greenland they are sought after by the walrus, the Arctic fox, and birds. (*O. Fabricius.*)

Platyodon, Conrad, 1837.

Distr.—*P. cancellata*, Conr. (cvi, 28). California.

Shell ventricose, with concentric, undulating striæ, and a small groove from the apex to the ventral margin; posterior side short, radiately striated, spoon-shaped cardinal process dilated and biemarginated. Siphonal orifices furnished with four valvular testaceous appendages, which close them.

Tugonia, Gray, 1842.

Syn.—Le Tugon, Adanson.

Distr.—6 sp. West Coast of Africa. Fossil. Miocene; Dax, and the Morea. *T. anatina*, Gmel. (cvi, 21, 22).

Shell equivalve, globular or suboval, very inequilateral, widely gaping posteriorly; a spoon-shaped process and small cardinal tooth in each valve; ligament double, external and internal; pallial impression very short and simply arcuated.

Siphon very short, truncated, scarcely extending beyond the valves. Lives in indurated clay at the mouths of rivers, in Senegal.

FAMILY CORBULIDÆ.

Shell small, inequivalve, thick, gaping in front; hinge consisting of a single recurved tooth in one valve, received into a fosset or notch in the other.

Animal unsymmetrical; mantle closed except in front, the narrow opening dentate; siphons united, short, fringed. Living in the sand or mud on the seashore or in estuaries.

CORBULA, Bruguière.

Etym.—*Corbula*, a little basket.

Syn.—Erodina, Daud. (= Pacyodon, Beck.) Agina, Turt.

Distr.—73 sp. United States, Norway, Britain, Mediterranean, West Africa, China. Inhabits sandy bottoms; lower laminarian zone—80 fathoms. Fossil, 120 sp. Inferior Oolite—; Europe, India. Laramie—; United States. *C. Mediterranea*, Costa (cv, 93). *C. sulcata*, Brug. (cv, 94).

Shell thick, inequivalve, gibbose, closed, produced posteriorly; right valve with a prominent tooth in front of the cartilage-pit; left valve smaller, with a projecting cartilage-process; pallial sinus slight; pedal scars distinct from the adductor impressions.

Animal with very short, united siphons; orifices fringed; anal valve tubular; foot thick and pointed; palpi moderate; gills two on each side, obscurely striated.

TÆNIODON, Dunker, 1851. Shell ovately elongated, subequilateral, smooth, equivalve, and apparently closed, right valve with a cardinal tooth under the umbo extending forwards, left valve with a distinct marginal cartilage-pit behind the beak. Type, *T. ellipticus*, from liassic beds near Halberstadt (Germany). The ligament was partially external, partly internal, the valves not gaping.

ANISORHYNCHUS, Conrad. Shell nearly or quite equivalve, transversely pyriform, the posterior side being rostrate; beaks nearly equal, and distinctly incurved. Hinge, muscular and pallial impressions as in Corbula, except that the cardinal tooth is furrowed.

C. pyriformis, Meek. Associated with fresh- and brackish-water types.

PACHYODON, Gabb, 1868. (Anisothyris, Conr.) *P. obliqua*, Gabb (cvii, 33–35). Associated with marine and estuary types.

BOTHROCORBULA, Gabb, 1872. Differs from the typical Corbulæ in having a deep lunular pit under the beaks, penetrating and almost passing through the hinge-plate. *C. viminea*, Guppy (cvii, 36, 37).

PTEROMYA, Moore. Resembles Corbula, but thin; smooth or concentrically striated. *Pt. Crowcombei*, Moore. Rhætic beds, at Beer-Crowcombe.

HIMELLA, H. Adams, 1860. Shell thin, with the left valve larger than the right one, not gaping; hinge of the right valve with an indistinct tooth fitting into a pit in the left valve; cartilage internal, lying in both valves in an almost horizontally extending process; an external ligament is besides present; pallial sinus scarcely noticeable. Based on *H. fluviatilis*, Maranon Riv.

POTAMOMYA, J. Sowerby, 1839. (Azara, d'Orbigny, 1839.) *P. gregaria.* Eocene; Isle of Wight. Cartilage-process broad and spatulate, received between two obscure teeth in the right valve. The estuary Corbulæ differ very little from the marine species. *C. labiata* lives buried in the mud of the River Plata, but not above Buenos Ayres, and consequently in water which is very little influenced by the superficial ebb of the river. The same species is found in banks widely dispersed over the Pampas near San Pedro, and many places in the Argentine Republic, five yards above the River Parana. (Darwin.) *C. erodina*, Lam. (cvi, 23–25).

CORBULAMELLA, Meek and Worthen, 1857. Shell subtriangular, subglobose, inequivalve, the right valve being more ventricose than the left; beaks nearly central; hinge with one cardinal tooth in each valve, apparently very similarly arranged in position to that of Corbula, but the existence of an internal cartilage has not as yet been satisfactorily proved; anterior muscular impression rather indistinct, posterior on a special raised or projecting plate; pallial impression scarcely sinuated posteriorly. *C. gregaria*, M. and H. (cv, 95). Cretaceous; Nebraska.

PLECTODON, Carpenter, 1865.

Distr.—*P. scaber*, Carp. Catalina Isl., Cal.

Shell thin, rough, rostrate; dorsal margin twisted within under the umbones, forming the cardinal tooth; lateral teeth long, laminated; cartilage-pit minute, concealed under the umbones; posterior lateral tooth contiguous; pallial sinus small.

Has the aspect of Theora, and appears allied to Neæra. It is probable that the cartilage was strengthened by an ossicle. The great peculiarity is the twisting-in of the dorsal margin, which ascends the umbo in a very loose spiral.

SPHENIA, Turton, 1822.

Distr.—4 sp. Britain, W. Coast of N. Am., Red Sea. Bur-

rowing in oyster-shells and limestone, in 10–25 fathoms. Fossil, 20 sp. Tertiary; Europe. *S. Binghami*, Turton (cv, 96).

Shell oblong; right valve with a curved, conic tooth in front of the oblique, subtrigonal cartilage-pit.

Animal with long, thick, united siphons, fringed at the end, anal valve conspicuous; foot finger-like, with a byssal groove. The prolonged siphons and the short digitiform byssiferous foot fairly distinguish the animals of this genus from those of Corbula. The hinge is occasionally very similar in both. As a rule the teeth in Sphenia become obsolete with age.

PORONYA, Forbes, 1843.

Etym.—Passing into the genus *Mya*.

Syn.—Eucharis, Recluz, 1850. Embla, Lovèn, 1846. *Cumingia parthenopæa*, Tiberi. ? Basterotia, Mayer.

Distr.—10 sp. Britain, Scandinavia, Mediterranean, Tropical America. Fossil, 13 sp. Cretaceous, Eocene; France, Germany, England, United States. *P. granulata*, Nyst. (cv, 97). *P. quadrata*, Hinds (cvi, 26).

Animal with unequal siphons, clothed with numerous filaments, foot narrow and slender.

Shell suborbicular, subequivalve, and inequilateral, thin, transparent, slightly nacreous within; valves closed, surface granulated; teeth, in right valve a short but strong cardinal, and in the left a minute triangular cardinal and a ridge-like lateral on the posterior side.

PLEURODESMA, Hörnes, 1859.

Distr.—*Pl. Mayeri*, Hörnes (cv, 98, 99). Tertiary; Europe.

Shell oblong or quadrangular, equivalve, closed on both sides, one large cardinal tooth in each valve, and a long groove extending along the dorsal margin of the shell for the reception of the cartilage; there is no indication of the presence of a ligament. This genus has been proposed for a tertiary shell, *Pl. Mayeri*, agreeing in general form with Eucharis, but differing widely in the form of the hinge.

CORBURELLA, Lycett.

Distr.—*C. curtansata*, Phil. Jurassic; England.

"Shell equivalve, thin, inflated, posteriorly attenuated and gaping, anteriorly rounded, hinge with a small, depressed subconical tooth in each valve, and extended, slightly thickened, laminar plate forming a kind of an anterior lateral tooth or process." Ligament and pallial sinus are not noticed, nor are they perceptible in the figure. In general form is near Neæra, but the tooth in each valve would recall Eucharis. Whether the anterior laminar process occurs in both valves and whether it is

for the purpose of supporting the cartilage, which seems likely, has yet to be satisfactorily determined.

SPHENIOPSIS, Sandberger, 1863.

Distr.—*S. scalaris*, Braun. Tertiary; Germany (cv, 1–3).

Shell subtrigonal, compressed, equivalve, posteriorly rostrate and slightly gaping; hinge of right valve with an anterior cardinal tooth, and a deep cartilage-pit behind it, a long laminar tooth runs along the areal margin; left valve edentulous, only provided with a cartilage-pit; pallial sinus deep.

NEÆRA, Gray, 1834.

Etym.—*Neæra*, a Roman lady's name.

Syn.—Cuspidaria, Nardo, 1840. Sphena, d'Orb., 1846.

Distr.—22 sp. Norway, Britain, Mediterranean, Canaries, Madeira, China, Moluccas, New Guinea, Chili; from 12–200 fathoms. Fossil, 14 sp. Oolite—; Britain, Belgium, Italy. *N. ornatissima*, Orb. (cv, 4, 5).

Shell globular, attenuated, and gaping behind; right valve a little the smallest; umbones strengthened internally by a rib on the posterior side; cartilage-process spatulate, in each valve (furnished with a movable ossicle—Deshayes), with an obsolete tooth in front, and a posterior lateral tooth; pallial sinus very shallow.

Animal with the mantle closed; foot lanceolate; siphons short, united, branchial largest, anal with a membranous valve, both with a few long, lateral cirri.

Placed by Messrs. Adams in the Anatinidæ, though judging from the form of the shell, being in many respects similar to that of Corbula, and also from the form of the small foot and the short siphons of the animal, there can be little doubt that Deshayes' classification near Sphænia, Corbula, etc., is the more correct one. Almost the only character which some species of the genus have in common with the Anatinidæ is the presence of a small ossicle at the cartilage, but as all the Anatinidæ do not possess the same, its presence cannot be regarded as an exclusive character of that family.

RHINOMYA, A. Ad., 1864. For those forms having the surface of the shells lamellar, like Neæra proper, but possessing a small triangular cartilage-pit, and two lateral teeth in the right valve. *N. Philippinensis*, Hinds.

CARDIOMYA, A. Ad., 1864. Species with the surface radiately ribbed. *N. Gouldiana*, Hinds.

CORBULOMYA, Nyst., 1846.

Etym.—*Corbula* and *Mya*.

Distr.—3 sp. Mediterranean. Fossil, 7 sp. Eocene; France, Belgium, England. *C. antiqua*, Desh. (cvii, 38).

Shell oval, transverse, depressed, closed, inequivalve, subinequilateral; right valve the larger, with one pyramidal tooth, and a narrow and deep socket; left valve with two unequal teeth separated by a large socket. Ligament internal, pallial impressions simple, slightly inflected posteriorly.

Animal with the mantle united behind, margins of the mantle with duplicate foliaceous tentacles; foot compressed, triangular; siphons short, united at the base, the incurrent tube the larger and more elongated, the opening of which is surrounded by arborescent tentacles.

DORSOMYA, Ryckholt, 1852. The shell resembles Corbulomya in shape, but the knowledge of the hinge is necessary for its correct generic determination. Carboniferous; Belgium. *D. dorsata.*

CRYPTOMYA, Conrad, 1848.

Distr.—8 sp. California, Australia, Philippines. *C. Philippinarum*, A. Ad. (cvi, 27).

Shell inequilateral, transverse, oblong, gaping behind; valves with radiating, sometimes crossed by concentric striæ; right valve with a lamellar tooth, left valve with a broad fosset; ligament internal; pallial impression with a small sinus.

Siphons short; not covered as in Mya with a coriaceous epidermis.

FAMILY ANATINIDÆ.

Shell often inequivalve, thin; interior nacreous; surface granular; ligament external, thin; cartilage internal, placed in corresponding pits and usually furnished with a free ossicle; muscular impressions faint, the anterior elongated; pallial line usually sinuated.

Animal with mantle-margins united; siphons long, more or less united, fringed; gills mostly single on each side, the outer lamina prolonged dorsally beyond the line of attachment.

Pholadomya and its fossil allies have an external ligament only; no ossicle. The external surface of these shells is often rough with large calcareous cells, sometimes ranged in lines, and covered by the epidermis; the outer layer consists of polygonal cells, more or less sharply defined; the inner layer is nacreous.

The most important distinctions of the shells are their thin pearly structure and usually edentulous hinge. These at least are almost the only characters upon which we can depend in the determination of fossil species. The shells are generally inequilateral, but sometimes the anterior, sometimes the posterior side is the longer, and the latter usually has a wide gap at the end.

There is a large amount of variation in the form of the animals, but they all have the mantle-margins united, with an opening at the antero-inferior side for the protrusion of a small

digitiform foot; the siphons are more or less prolonged, united in their entire length or only at the base, and the united portion of these siphons is almost invariably covered with an extension of the shell-epidermis. There is also a small opening in the mantle below, at the base of the siphons. The gills are thin and in many cases (though not invariably) single. The palpi are usually long and narrow.

There is scarcely any other family of Pelecypoda so important to the palæontologist, being represented throughout the strata from the oldest sedimentary deposits. The species living at the present time may be said to be only the remnants of the group; they are distributed all over the world, but they are nowhere very numerous, and some of them belong to the rarest yet known shells. Their maximum of development appears to have been during the Jurassic period.

(*Pandoræ.*)

PANDORA (Solander), Bruguière, 1792.

Etym.—*Pandora*, the Grecian Eve.

Syn.—Pandorella, Conrad.

Distr.—24 sp. United States, Spitzbergen, Jersey, Canaries, India, New Zealand, Philippines, Panama; 4–110 fathoms, burrowing in sand and mud. Fossil, 14 sp, Eocene—; United States, Britain. *P. oblonga*, Sowb. (cviii, 48). *P. inæquivalvis*, Linn. (cviii, 49).

Shell inequivalve, thin, pearly inside; valves close, attenuated behind; right valve flat, with a diverging ridge and cartilage-furrows; left valve convex, with two diverging grooves at the hinge; usually no ossicle; pallial line slightly sinuated. Outer layer of regular vertical, prismatic cells.

Animal with mantle closed, except a small opening for the narrow, tongue-shaped foot; siphons very short, united nearly throughout, ends diverging, fringed; palpi triangular, narrow; gills plaited, one on each side, with a narrow dorsal border.

KENNERLIA, Carp., 1864. Under this name are separated a few species, which still more resemble Myodora, than the true Pandoræ. They all have a thin hinge-ossicle, and the typical species have radiating ribs on the right valve. *P. bicarinata*, Carp.

CŒLODON, Carp., 1864. The form of the shell is similar to that of Pandora; each valve with two hinge-teeth directed towards the anterior adductor muscle, and in the left one they are connected by a thin lamina; no ossicle or pallial sinus. *P. Ceylonica*, Sowb. (cviii, 47).

CLIDIOPHORA, Carp., 1864. Similar in form to the last; right valve rather tumid, with three hinge-teeth; the posterior one elongated; left valve often with two teeth; ossicle present,

pallial line simple. All the species at present known are from North American seas. *P. claviculata*, Carp.

MYODORA Gray, 1840.

Distr.—12 sp. New Zealand, New South Wales, Philippines. *M. striata*, Quoy (cviii, 50).

Shell trigonal, rounded in front, attenuated and truncated behind; right valve convex, left flat; interior pearly; cartilage narrow, triangular, between two tooth-like ridges in the left valve, with a free sickle-shaped ossicle; pallial line sinuated; structure like Anatina; outer cells large, rather prismatic.

MYOCHAMA, Stutchbury, 1830.

Distr.—5 sp. New South Wales; attached to Crassatella and Trigonia, in 8 fathoms water; the fry (as indicated by the umbones) is free, regular, and Myodora-shaped. *M. anomioides*, Stutchb. (cviii, 51–53). *M. Keppelliana*, A. Ad. (cviii, 54).

Shell inequivalve, attached by the dextral valve and modified by the form of the surface of attachment; posterior side attenuated; left valve gibbose; cartilage internal, between two tooth-like projections in each valve, and furnished with a movable ossicle; anterior muscular impression curved, posterior rounded, pallial sinus small.

Animal with mantle-lobes united; pedal opening and siphon surrounded by separate areas; siphons distinct, unequal, small, slightly fringed; a minute fourth orifice close to the base of the branchial siphon; visceral mass large, foot small and conical; mouth rather large, upper lip hood-like; palpi tapering, few-plaited; gills one on each side, triangular, plaited, divided by an oblique line into two portions; excurrent channels four, two at the base of the gills and two below the dorsal laminæ.

(*Thraciæ.*)

ASTHENOTHÆRUS, Carpenter, 1864.

Distr.—*A. villosior*, Carp. Cape St. Lucas, L. Cal.

Shell like Thracia, hinge without teeth, spongy cartilage situated in a pit under the umbones.

THRACIA (Leach), Blainville, 1824.

Syn.—Odoncinetus, Costa. Cinctodonta, Herm. Corymya, Agassiz.

Distr.—27 sp. Greenland, United States, Norway, Britain, Mediterranean, Canaries, China, Sooloo; 4–110 fathoms. Fossil, 36 sp. (Trias?) Lower Oolite—; United States, Australia, Europe. *T. pubescens*, Pult. (cviii, 55). *T. plicata*, Desh. (cviii, 56).

Shell oblong, nearly equivalve, slightly compressed, attenuated and gaping posteriorly, smooth, or minutely scabrous; cartilage-processes thick, not prominent, with a crescentic ossicle; pallial sinus shallow. Outer shell-layer composed of distinct, nucleated cells.

Animal with the mantle closed; foot linguiform; siphons rather long, separate, with fringed orifices; gills single, thick, plaited; palpi narrow, pointed.

T. concentrica and *T. distorta*, Mont., are found in the crevices of rocks, and burrows of Saxicava; they have been mistaken for boring-shells.

RUPICOLA, Bellevue, 1802. (Ixartia, Leach, 1852. Ligula, Recluz.) Shell irregularly suboval, hinge with a vertical cartilage-process; pallial sinus small, obtuse, triangular. Siphonal orifices simple. *T. concentrica*, Bellevue.

T. declivus, Recl., is the type of Ligula, which does not appear to differ essentially from Rupicola.

CALCARA, Recluz, 1868. (Periplomya, Conr.) Form typical of the Thraciæ, nearly equilateral, equivalve, hinge with a spoon-shaped cartilage-process in each valve directed anteriorly, pallial sinus deep. This name has been proposed for the fossil *Anat. oblonga*, Philippi.

PERIPLOMA, Schumacher, 1817.

Syn.—Anatina (partim), Lam. Bontia, Leach, Brown, 1844. Galaxura, Leach.

Distr.—12 sp. U. S., W. Indies, Panama, So. America. *P. inæquivalvis*, Schum. (cviii, 57–59).

Shell oval, very inequivalve, inequilateral, slightly nacreous; left valve deepest; posterior side very short and contracted; hinge with a narrow, oblique, spoon-shaped process in each valve, and a small triangular ossicle; an internal rib proceeds from under the hinge to the posterior margin; muscular impressions unequal, the anterior long and narrow, the posterior small, semi-lunar; pallial impression marginal. Siphons long and slender, separate.

COCHLODESMA, Couthouy. Oblong, compressed, thin, slightly inequivalve; umbones fissured; cartilage-processes prominent, ossicle minute; pallial sinus deep. Animal with a broad, compressed foot; siphons long, slender, divided throughout; gills one on each side, deeply plaited, divided by an oblique furrow into two parts, the dorsal portion being narrower, composed of a single lamina only, and attached by its whole inner surface. 2 sp. U. S., Britain, Mediterranean. Fossil. Pliocene; Sicily. *T. prætenuis*, Mont. (cviii, 60). *T. Leana*, Couth. (cviii, 61). Hardly distinct from the typical group.

PELOPIA, H. Adams, 1868. Shell oval, inequivalve, closed on

both ends, surface scabrous; hinge with a long, horizontal excavated cartilage-process; ligament placed in a deep groove. *Pel. brevifrons*, H. Ads. (cviii, 62, 63), is the type of the group, which differs from Periploma by the want of an internal rib below the cartilage-process and by not having the beaks fissured.

ALICIA, Angas, 1867.

Distr.—2 sp. Port Jackson, Australia. *A. angustata*, Angas (cviii, 64, 65).

Shell inequivalve, resembling a small Thracia, but the posterior portion is much smaller than the anterior, internally subnacreous; beaks entire; hinge composed of a posterior callus in the right valve fitting in a cavity in the left one, and an anterior marginal tooth or ridge; cartilage internal under the umbones, covered by a large triangular ossicle; pallial line deeply sinuated.

LYONSIA, Turton, 1822.

Syn.—Magdala, Leach, 1827. Hyatella, Brown. Pandorina, Scacchi.

Distr.—18 sp. Greenland, North Sea, Norway, West Indies, Madeira, India, Borneo, Philippines, Peru. Fossil? Miocene—; Europe. (100 sp. Lower Silurian—. D'Orbigny.)

Shell nearly equivalve, left valve largest, thin, subnacreous, close, truncated posteriorly; cartilage-plates oblique, covered by an oblong ossicle; pallial sinus obscure, angular. Structure intermediate between Pandora and Anatina; outer layer composed of definite polygonal cells.

Animal with the mantle closed; foot tongue-shaped, grooved, byssiferous; siphons very short, united nearly throughout, fringed; lips large, palpi narrow, triangular.

L. Norvegica (cviii, 66) ranges from Norway to the sea of Ochotsk; in 15–80 fathoms.

LYONSIELLA, Sars, 1868. *L. abyssicola*, Sars.

SOULEYETIA, Recluz. Shell inequilateral, spoon-like process directed backwards.

? ENTODESMA, Phil. Shell thin, Saxicava-shaped, slightly inequivalve and gaping, covered with thick epidermis; hinge edentulous; each valve with a semicircular process containing the cartilage. Ossicle and pallial impression not observed. *E. Chilensis*, Phil. (cviii, 67).

(*Anatinæ.*)

Mostly fossil. The classification is very unsatisfactorily known. Some forms are tumid and cordate, like the recent Mytilimeriæ or the fossil Cercomyæ, and others are elongated and considerably compressed, as the typical Anatinæ and the

fossil Corimyæ. But among the enormous number of known Pholadomyæ, we meet similar variations in one and the same genus.

MYTILIMERIA, Conrad, 1837.

Distr.—2 sp. *M. Nuttalli*, Conr. (cviii, 68).

Shell rounded-oval, more or less ventricose, equivalve, fragile, covered by a thin caducous epidermis; beaks subspiral; hinge without teeth, but formed of small linear excavations under the beaks to receive the ligament, which contains a small ossicle; muscular impressions small; pallial impression with an obtuse sinus.

Animal gregarious, forming a nest.

EDMONDIA, Koninck, 1842.

Distr.—Fossil, 4 sp. Carb.—Permian; Europe. *E. unioniformis*, Phil. (cvii, 39).

Shell oblong, equivalve, thin, concentrically striated, close; umbones anterior; ligamental grooves narrow, external; hinge-line thin, edentulous, furnished with large oblique cartilage-plates, placed beneath the umbones, and leaving space for an ossicle? or the plate may be equivalent to the subumbonal blade in Pholas; pallial line simple?

CARDIOMORPHA, Koninck, 1842.

Distr.—Fossil, 38 sp. Lower Silurian—Carb.; N. America, Europe. *C. excentrica*, Agass. (cvii, 40).

Type, *C. oblonga* (Isocardia), Sowerby (not Koninck). Carboniferous.

Shell Isocardia-shaped, smooth or concentrically furrowed, umbones prominent, hinge edentulous; hinge-margin with a narrow ligamental furrow, and an obscure internal cartilage-groove.

CEROMYA, Agassiz, 1842.

Etym.—*Keraos*, horned; *mya*, mussel.

Distr.—Fossil, 14 sp. Inferior Oolite, Greensand; Europe. *C. Aalensis*, Quenst. (cvii, 41, 42).

Shell Isocardia-shaped, slightly inequivalve? very thin, granulated, often excentrically furrowed; ligament external; hinge edentulous; right valve with an internal lamina behind the umbo; pallial line scarcely sinuated?

The Ceromyæ are principally characterized by their tumid, thin and concentrically laminated shell, distant beaks, and the oblique furrows which are externally traceable. Chenu unites this to Cardiomorpha, but in that genus there does not appear to be any such arrangement for the attachment of an internal ligament (similar to that of Lyonsia); there is along the raised

upper margin no trace of a special furrow, and the beaks are closely approximate to each other.

GRESSLYA, Agassiz, 1842.

Distr.—50 sp. Lias, Jura; Europe. *G. zonata*, Agass. (cvii, 43).

Shell oval, rather compressed; umbones anterior, incurved, not prominent; valves thin, close, smooth or concentrically furrowed; pallial sinus deep. The lamina within the posterior hinge-margin of the right valve produces a furrow in the casts, which are more common than specimens retaining the shell.

ALLORISMA, King, 1844.

Syn.—Cercomyopsis, Meek.

Distr.—Devon., Carboniferous. *A. sulcata*, Flem. (cvii, 44).

Shell transversely elongated, very thin, elliptical, equivalve, very inequilateral; each valve with an elongated ligamentary support; hinge without teeth; valves concentrically plicate, in some species radiately punctate, in others the very small punctations are distributed without order.

MYACITES (Schlotheim), Bronn.

Distr.—Fossil, 50 sp. Triassic—Lower Chalk; United States, Europe, South Africa.

Shell oblong, ventricose, gaping, thin, often concentrically furrowed; umbones anterior; surface granulated; ligament external; hinge with an obscure tooth or edentulous; muscular impressions faint; pallial line deeply sinuated.

PACHYMYA, Sowb., 1826. Shell transversely elongated, modioliform, equivalve, thick; beaks subterminal. Cretaceous.

HOMOMYA, Agassiz, 1842. Shell very thin, transverse, oval, ventricose, inequilateral, gaping at the extremities; hinge without teeth; beaks thick, rounded, a little curved. Jurassic.

PLEUROMYA, Agassiz, 1842. (Anoplomya, Krauss.) Shell elongated or ovoid, very thin, nearly papyraceous, concentrically furrowed; beaks large, swollen, anterior, recurved in front, contiguous; pallial impression with a large, profound sinus, rarely distinct. D'Orbigny has found cardinal teeth in well-preserved specimens, and refers Pleuromya to Panopæa. Several sp. Liassic and Jurassic *P. tenuistriata*, Agass.

MYOPSIS, Agassiz, 1845. Shell moderate or large sized, covered with linear points forming radiating lines, more or less gaping at both extremities; a cardinal tooth in each valve; beaks more or less anterior, sometimes even marginal; pallial impression with a profound sinus; muscular impressions indistinct. 25 sp. Jurassic and Cretaceous; Europe. *M. lata*, Agass. (cvii, 45).

ARCOMYA, Agassiz, 1842. Shell very thin, much elongated transversely, sometimes compressed, sometimes more or less

cylindrical, gaping at both extremities, greatly posteriorly; beaks small, narrow, pointed, nearly contiguous, not elevated and but little curved; anterior muscular impressions oval or pyriform, posterior rounded; pallial impression indistinct. 12 sp. Liassic and Jurassic. Europe. *M. oblonga*, Agass. (cviii, 69).

MACTROMYA, Agassiz, 1842. (Plectomya, Loriol.) Shell swollen or globular, very thin, striate; hinge without teeth—at least none are visible on the internal casts; an internal rib proceeds from before the beaks obliquely to the anterior margin. Cretaceous and Jurassic; Europe. *M. rugosa*, Agass. (cvii, 46).

SEDGWICKIA, M'Coy, 1844.

Distr.—S. attenuata, M'Coy. Carb.; Europe. Sil.; N. Y.

Shell elongated, inequilateral, anteriorly rounded and shorter, posteriorly subtruncated, moderately tumid, with incurved beaks, anterior half of the surface ornamented with concentric sulcations, becoming obsolete posteriorly, hinge edentulous.

PYRENOMÆUS, Hall, 1852. Elongated, inequilateral, anteriorly rounded, posteriorly attenuated and produced, concentrically striate-sulcated on the surface; beaks tumescent, anterior muscular impression deep, subanterior (posterior unknown); hinge apparently without teeth?

P. cuneatus, Hall (cxx, 15). Clinton group (Middle Silurian) of North America. Perhaps belongs in Nuculidæ.

LEPTODOMUS, M'Coy, 1844. Shell oblong, somewhat trapezoid, tumid, very thin, anteriorly rounded, beaks subanterior, posteriorly subtruncate and gaping, concentrically sulcated; beaks incurved, with a somewhat excavated lunule below; hinge without teeth, the posterior hinge-line more or less straight, muscular and pallial impressions faint. *L. fragilis*, M'Coy. The species are all palæozoic; those with a median sulcus extending from the beaks to the ventral edge seem to be more correctly referable to Grammysia; the typical forms greatly resemble some Cypricardiæ, but are readily distinguished from them by their thin shells.

TYLERIA, H. and A. Adams, 1854.

Distr.—T. fragilis, H. and A. Ad. (cviii, 70). Mazatlan.

Shell oblong, rounded in front, gaping behind, covered by a very slight epidermis; valves thin, nearly membranaceous; cartilage inserted in a spoon-shaped hollow; interior of shell with a layer of carbonate of lime between the spoon-shaped hollow and the anterior edge; pallial line with a profound sinus.

ANATINA, Lamarck, 1809.

Etym.—Anatinus, pertaining to a duck. Lantern-shell.

Syn.—Laternula, Bolten, 1798. Auriscalpium, Muhlf., 1811. Rhynchomya, Agass.

Distr.—37 sp. India, Philippines, New Zealand, Japan, United States. Fossil, 50 sp. Devonian?—Oolite—; United States, Europe. *A. truncata*, Lam. (cviii, 71).

Shell oblong, ventricose, subequivalve, thin and translucent, posterior side attenuated and gaping; umbones fissured, directed backwards, supported internally by an oblique plate; hinge with a spoon-shaped cartilage-process in each valve, furnished in front with a tranverse ossicle; pallial sinus wide and shallow.

Animal with a closed mantle and long united siphons, clothed with wrinkled epidermis; gills one on each side, thick, deeply plaited; palpi very long and narrow; pedal opening minute, foot very small, compressed.

PLATYMYA, Agassiz, 1838. Some of the species of this fossil group are more compressed than the recent Anatinæ, but it can scarcely be considered generically distinct. *A. rostrata*, Agass.

CERCOMYA, Agassiz, 1842. Shell elongated, compressed; beaks fissured; posterior slope frequently angulated. Jurassic, Cretaceous. *A. gracilis*, of Australia, is a recent species. *A. striata*, Agassiz (cviii, 72). Jurassic.

PLECTOMYA, Loriol, 1868. Shell ovately elongated, equivalve, beaks subcentral, a strong oblique rib posterior to them; hinge edentulous; ligament external. Based on a well-known Jurassic fossil, the *Tellina rugosa* of Römer. Appears to be scarcely distinguishable, however, from Platymya.

PERIPLOMYA, Conrad, 1870. (Leptomya, Conrad [not A. Adams], 1867. Plicomya, Stoliczka, 1870.) Shell oblong, perlaceous, gaping anteriorly; hinge with a spoon-shaped cartilage-process, forming an oblique callosity, which extends to the cardinal margin; an obsolete rib and fissure run obliquely from the anterior side of the beak. The genus is evidently closely allied to Anatina, from which it chiefly differs by the rib and fissure anterior to the beak. Based on a North American cretaceous species. *P. applicata*, Conrad.

ANATIMYA, Conrad, 1860. Shell oblong, like an Anatina, anterior side with concentric sulci, posterior with radiating ribs. Only American and cretaceous. *A. anteradiata*, Conr. (cviii, 73).

ANTHRACOMYA, Salter, 1861.

Etym.—*Anthrax*, coal, and *mya*, a generic name.

Syn.—Naiadites, Dawson.

Distr.—9 sp. Coal-measures, associated with marine animals. Great Britain, Nova Scotia. *A. Adamsi*, Salter.

Shell thin, equivalve, the right valve rather larger; valves close, oblong, wider behind, where there is a blunt siphonal ridge; rounded anteriorly, with a byssal sinus on the anterior ventral edge. Beaks small, anterior, and slightly prominent,

with an obscure lunette; posterior hinge-line with a narrow interior ridge; ligament external. Epidermis strongly wrinkled.

Animal unknown; probably had a closed mantle and respiratory siphons.

CYATHODONTA, Conrad, 1849.

Distr.—4 sp. China, L. Cal., Honduras. *C. granulosa*, Ads. and Reeve (cviii, 74).

Shell like Anatina in form; "hinge with a broad, not very projecting fosset, which is carinated near the margin; muscular impressions rounded, indistinct; pallial impression with a large, rounded sinus."

GONIOMYA, Agassiz, 1838.

Syn.—Lysianassa, Munst., 1838.

Distr.—Cretaceous and Jurassic. *G. Duboisi*, Agass. (cviii, 75).

Shell oblong, rather compressed, thin, surface marked about the middle of the flanks with angularly bent striæ or ribs; hinge without teeth; a slight incision below the beaks, and slightly thickened nymphæ beyond the same for the attachment of a ligament are present.

CHÆNOMYA, Meek, 1865.

Syn.—Anoplomya, Krauss.

Distr.—Cretaceous, Jurassic. *C. Cooperi*, Meek (cix, 84).

Shell oblong, equivalve, inequilateral, thin, concentrically striated or ribbed, with an oblique process below the beaks of each valve, probably supporting an internal cartilage; nymphæ prominent for the attachment of an external ligament; sinus very deep and usually angular.

Terquem has sufficiently proved that this a good genus, and must be kept separate from Homomya, Myacites and Panopæa, which it externally greatly resembles.

Shell much like Anthracomya, of thin structure, more or less compressed, posteriorly gaping.

PHOLADOMYA, G. Sowerby.

Syn.—Procardia, Meek.

Distr.—2 sp. West Indies, off Rhode Island. *P. candida*, Sowb. (cviii, 76, 77). Fossil, 160 sp. Lias—; United States, Europe, Algeria, Thibet. *P. exaltata*, Agass. (cix, 85). *P. glabra*, Agass. (cix, 86).

Shell oblong, equivalve, ventricose, gaping behind; thin and translucent, ornamented with radiating ribs on the sides; ligament external; hinge with one obscure tooth in each valve; pallial sinus large.

Animal with a single gill on each side, thick, finely plaited, grooved along its free border, the outer lamina prolonged dorsally; mantle with a fourth (ventral) orifice.—OWEN.

Pholadomya was largely represented in the Jurassic, decreased considerably in the tertiary period, and is now nearly extinct.

CYMELLA, Meek, 1864. Shell small, subequilateral, ovate, with numerous well-defined concentric undulations, crossed on the middle of the valves by a few impressed lines, not marked in the depression between the ridges. *P. undata*, M. and H. Cretaceous; Texas.

LIOPISTHA, Meek. Shell transversely subovate, ornamented, excepting on the posterior dorsal portions of the valves, by regular, simple, well-defined, sometimes subcrenate, radiating costæ. *P. elegantula*, Römer. Cretaceous; Texas. *P. frequens*, Zitt. (cix, 87).

PSILOMYA, Meek. Radiating striæ or ridges nearly or quite obsolete, the radiating rows of granules or spines, usually more distinct; sometimes with well-defined concentric furrows and ridges. *P. superba*, Stoliczka.

MACHOMYA, Loriol, 1868. Shell oblong, subcompressed, equivalve, strongly inequilateral, rather solid and with punctated surface; a strong, radiating rib issues from the umbones, and runs towards the anterior margin; ligament external, solid. The hinge is not known, but the form of the shell, with its strong external ligament, appears to form a passage to the Panopæa. *M. Dunkeri*, Orb. Jurassic.

MARGARITARIA, Conrad, 1862. Its peculiar muscular and pallial impressions should perhaps rank it as a genus. It has not been characterized. *P. abrupta*, Conrad. Miocene; Atlantic Slope, United States.

? ACTINOMYA, Ch. Mayer. Appears to = Margaritaria.

PALANATINA, Hall, 1869.

Distr.—*P. typa*, Hall. Fossil. Chemung Gr., New York.

Shell transversely elongate, very inequilateral, inequivalve, and gaping at the extremities; left valve the larger and most convex, with a subangular umbonal ridge, and a broad, shallow, anteromesial constriction passing obliquely from beak to base; the beak small and prominent; right valve much less convex, with a smaller beak and faint umbonal ridge and sinus; valves united by a small external ligament; hinge without lateral teeth, but provided with a small, hook-like process in each valve, just anterior to the beaks, which may have served the purpose of teeth, or more probably for the support of an internal cartilage; muscular impression very small and indistinct; the anterior scar rounded, situated just in front of the beak, and near the cardinal margin; the posterior scar somewhat larger, situated about one-third the distance from the beaks to the posterior extremity; pallial line not satisfactorily determined, but no evidence of a sinus has been detected; exterior surface marked by fine concentric striæ.

NEÆROMYA, Gabb, 1872.

Distr.—*N. quadrata*, Gabb (cviii, 78–80). Tertiary; West Indies.

Shell thin, translucent, in shape approaching Pholadomya, ends closed; hinge with a prominent tooth in the right valve, articulating behind a smaller similar one in the left valve; an anterior and posterior lateral tooth in each valve; mantle-margin without sinus.

This genus, in its thin character and minute hinge, is closely allied to Pholadomya, Thetis, and Neæra, but differs from all in the details of the hinge. Neæra has no cardinal tooth, but in its place a cartilage-pit in each valve; it has a single posterior tooth, while this genus has the anterior equally well-developed. In having corresponding teeth in both valves it differs from Thetis, while its well-specialized hinge and its closed ends distinguish it from Pholadomya.

OSTOMYA, Conrad, 1874.

Distr.—*O. papyria*, Conr. (cviii, 81, 82). Tertiary; Upper Amazon.

Shell thin, concentrically plicate; hinge with a spoon-shaped oblique fosset in the left valve, and a small tooth near the apex; right valve cartilage-fosset very oblique, almost parallel with the hinge-line.

TELLINOPSIS, Hall, 1869.

Syn.—Tellinites, M'Coy (part).

Distr.—*T. subemarginata*, Conr. (cviii, 83). Fossil. Hamilton Group, New York.

Shell thin, fragile, general form of Tellina, with moderately convex valves, small subcentral beaks, having their apices directed backwards with a shallow posterior furrow; hinge apparently edentulous; ligament external, small; muscular impression very faint, situated near the cardinal extremity; pallial line undetermined.

SANGUINOLITES, M'Coy, 1844.

Syn.—Cypricardites, Conr., 1841 (part).

Distr.—Carbon.; Eur. *S. discors*, M'Coy.

Very elongated, with subparallel upper and lower margins, rounded anteriorly, obliquely truncate posteriorly, with an oblique prominent ridge from the beaks to the postero-inferior margin, very inequilateral, beaks slightly prominent, close together, subanterior; anterior muscular impression oval, distinct, with a small groove above it, and both posteriorly bounded by a prominent ridge, posterior muscular scar faint; cardinal margin internally thickened the whole length, probably for the support of a ligament; surface concentrically (or

radiately? sometimes partially) striated or sulcated. Only palæozoic species are referred to the genus; some of them are in external form almost identical with Pharella, and it as yet remains to be shown whether there are in Sanguinolites any hinge-teeth or not. In the Brit. Pal. foss. (p. 276), M'Coy considers this genus apparently identical with King's Allorisma, which is very doubtful.

POMACRUS, Meek, 1871. Shell thin, more or less elongate-subtrapeziform, nearly or quite equivalve, either inequilateral or equilateral, the beaks being nearer the anterior or posterior end, or central, according to the species; valves closed all around, and each with a well-defined keel or more obtuse ridge extending from the posterior side of the beaks to the posterior basal extremity; anterior side attenuated and produced; posterior margin wider (higher) than the other, and obliquely truncated; dorsal margin sloping in front of the beaks, and more nearly horizontal and apparently without an escutcheon behind them; ligament external or marginal, rather long; surface with concentric lines and ridges, and sometimes obscure radiating markings on the umbonal region. Hinge, muscular, and pallial impressions unknown. *P. nasutus*, Meek. 2 sp. Carb.; Missouri.

PYANOMYA, Miller, 1882.

Distr.—*P. gibbosa*, Miller (cxx, 9, 13). Hudson Riv. Group; Cincinnati, Ohio.

Shell small, inequilateral, with thin, fragile, ventricose, edentulous valves, united by an external ligament; no escutcheon.

GRAMMYSIA, de Verneuil, 1847.

Distr.—Silur., Devon.; N. Am., Eur. *G. pes-anseris*, Sandb. (cxx, 14). *G. ovata*, Sandb. (cxxi, 5).

Shell equivalve, inequilateral, transverse; not gaping; muscular impressions very unequal; pallial line posteriorly rounded, bordering the large muscular impression so as to leave the latter two-thirds without it; ligament exterior, prolonged, in a depression of the dorsal line; surface with one or more oblique ribs, and several rounded concentric plications.

ORTHONOTA, Conrad, 1841.

Distr.—*O. undulata*, Conr. *O. contracta*, Conr. (cxxix, 13, 14). L. Silur.; U. S.

Shell narrow, with subparallel upper and lower margins, very inequilateral, the beaks being subanterior and tumescent, lunula in front of the beaks somewhat excavated, very thin, surface posteriorly generally undulately striated, hinge apparently without teeth.

CUNEAMYA, Hall and Whitfield, 1875.

Distr.—*C. Miamiensis*, H. and W. (cxx, 6). Silurian; Ohio.

Thin, fragile, bivalve shells, with ventricose valves, and strong, prominent, incurved beaks; cardinal line straight or gently curved; hinge edentulous; valves united by an external ligament of greater or less extent, posterior to which the margins of the valves overlap each other to the extent of the cardinal line; margins of the valves inflected along the cardinal border, forming a narrow escutcheon posterior to the beaks, and anteriorly a well-defined lunule is situated below the beaks; adductor muscles, at least two, are anterior and posterior; pallial line simple.

ORTHODESMA, Hall and Whitfield, 1875.

Distr.—*O. recta*, H. and W. (cxx, 7). Hudson Riv. Gr.; Ohio.

More or less elongate, bivalve shells, having the hinge-line straight and generally extended posterior to the beaks, but contracted or bent beneath or anterior to them; hinge-plate apparently edentulous; valves united by an external ligament extending to a greater or less distance along the posterior cardinal margin. Posterior muscular scar elongate-ovate, anterior scar smaller, both faintly marked; pallial line simple. Shells thin, marked externally with irregular concentric plicæ.

ILIONIA, Billings, 1874.

Distr.—3 sp. Sil., Devon.; U. S. *I. sinuata*, Hall.

Shell (cast) irregularly ovate, compressed or sublenticular, one extremity larger than the other; beaks turned towards the larger end, which is therefore supposed to be anterior; a concave depression commences on the umbones and extends downwards to the posterior ventral margin; a large subovate muscular impression in the upper half of the posterior extremity; close under the beaks in front there appears to have been a short escutcheon; no teeth.

CLARKIA, Koninck, 1878.

Distr.—*C. Myiformis*, Dana. Carb.; N. S. Wales.

Shell elongated, equivalve, gaping at its anal extremity, rather thick, with growth-lines; ligament external; hinge thick, callous, with a small tooth in each valve immediately under the beak; interior surface smooth; adductor and pedal impressions separate, the first large, oval, but slightly marked, the last stronger and small; pallial line nearly simple, slight.

[RIBEIRIA, Sharpe, 1853.

Distr.—Fossil, 4 sp. L. Silurian; Portugal, Canada, England.

Shell gaping at both ends; subovate, rounded in front, elon-

gated and rather attenuated behind; punctate-striate; casts of interior with a large umbonal impression (caused by a cartilage-plate, as in Lyonsia ?) and a notch in front of it.

Mr. Billings describes in this genus, "beneath and in front of the umbo, a small aperture of a semicircular shape, which appears to be the entrance to a tubular passage running backwards over the transverse plate into the general cavity of the body." He regards it as a byssal orifice.

Mr. J. W. Salter referred this genus to the class Crustacea.]

(*Veneracea.*)

FAMILY MACTRIDÆ.

Shell equivalve, trigonal, close, or slightly gaping; ligament (cartilage) internal, sometimes external, contained in a deep triangular pit; epidermis thick; hinge with two diverging cardinal teeth, and usually with anterior and posterior laterals; pallial sinus short, rounded.

Animal with the mantle more or less open in front; siphonal tubes united, orifices fringed; foot compressed; gills not prolonged into the branchial siphon.

SUBFAMILY *MACTRINÆ.*

Shell oval or subtriangular, nearly close behind; lateral teeth distinct, lamellar, well-developed.

MACTRA, Linn., 1767.

Etym.—*Mactra*, a kneading-trough.

Distr.—150 sp. All seas, especially within the tropics; —35 fathoms. Fossil, 30 sp. Lias—; United States, Europe, India. *M. turgida*, Gmel. (cix, 89–91).

Shell nearly equilateral; anterior hinge-tooth Λ-shaped, with sometimes a small laminar tooth close to it; lateral tooth doubled in the right valve.

Animal with the mantle open as far as the siphons, its margins fringed; siphons united, fringed with simple cirri, anal orifice with a tubular valve; foot large, linguiform, heeled; palpi triangular, long and pointed; outer gills shortest.

The Mactras inhabit sandy coasts, where they bury just beneath the surface; the foot can be stretched out considerably, and moved about like a finger; it is also used for leaping. They are eaten by the star-fishes and whelks, and in the Isle of Arran *M. subtruncata* is collected at low-water to feed pigs.—ALDER.

MACTRA (restricted). (Trigonella [Da Costa], Adams.) Cardinal teeth moderate; lateral teeth elongated, linear, subequal;

marginal ligament triangular, separated in the pit by a testaceous lamina; pallial sinus rounded.

SCHIZODESMA, Gray, 1837. Ligament not distinctly separate from the cartilage (the character does not appear to be very constant); pallial sinus angular. *M. Spengleri*, Gray (cix, 92–94).

HEMIMACTRA, Swains., 1840. (Spisula and Standella, Gray, 1849.) Shell trigonal; posterior slope more or less carinated; cardinal teeth moderate, laterals elongated; ligament triangular, submarginal, not separated by a testaceous lamella from the cardinal pit; pallial sinus small, rounded. *M. solidissima*, Chemn. (cix, 95). *M. triangula*, Brocc. (cix, 96).

MACTROMERIS, Conr. Not characterized. *M. ovalis*, Gould (cx, 22).

OXYPERAS, Mörch, 1853. Proposed for the more elongated triangular forms of Hemimactra, concentrically plicate-striate. *M. triangularis*, Lam. (cix, 97).

CYMBOPHORA, Gabb, 1869. Proposed for *Mactra Ashburnerii*, a cretaceous species. Form as in the typical Mactra, but the hinge is composed of a rather heavy hinge-plate, bearing a cartilage-pit, not sunk into its substance, as in other genera of the Mactridæ, but, as it were, built upon its surface; a small delicate spoon-shaped process laid obliquely under the beaks, its base being on or slightly above the level of the hinge-plate; in the right valve the cardinal tooth is single, very delicate, and nearly at a right-angle with the anterior wall of the cartilage-pit; in the left valve the tooth is Λ-shaped, entirely separated from the pit, very slender, and articulates between the tooth and the pit of the opposite side; the lateral teeth are large and very robust.

MULINEA, Gray, 1836. Shell oval-trigonal, subangular on each slope; cardinal teeth strong, laterals short and simple; internal ligament in the cardinal pit; pallial sinus angular. *M. edulis*, King (cix, 98–100).

MACTRINULA, Gray, 1849. (Blainvillia, Hupè, 1854.) Shell thin, trigonal, posterior slope shortest, angulated, cardinal teeth thin, the short laterals close to them; outer ligament separated from the cardinal pit by a testaceous lamella. *M. plicataria*, Linn. (cix, 1).

MACTRELLA, Gray, 1849. Shell thin, triangular; cardinal teeth thin, lateral posterior tooth very short, rudimentary, and close to the cardinal tooth; marginal ligament triangular, separated from the cartilage-pit by a lamella; pallial sinus rounded, profound. *M. alata*, Spengl. (cix, 2–4).

HARVELLA, Gray, 1849. Shell thin, trigonal, well rounded inferiorly, posterior slope very narrow, carinated, its margin nearly straight; surface concentrically plicate; cardinal teeth

thin, with the very thin, short lateral teeth closely approaching them; ligament separated from the cartilage-pit by a lamella; pallial sinus rounded. *M. elegans*, Sowb. (cix, 5, 6), is the only species. Harvella has been considered a genus, with the two preceding groups as subgenera of it, but they are all essentially Mactras.

MACTRODESMA, Conrad, 1868. Shell subtriangular; cartilage-pit very large, ovate and projecting much beyond the lower margin of the hinge-plate; anterior hinge-margin in the right valve thick and continued much beyond the beak; hinge of left valve with a profoundly elevated Λ-shaped cardinal tooth, connected with the hinge-line above it only at the base of the tooth; lateral teeth short, thick, subequal; pallial sinus narrower and deeper than in Mactra, ending in a line opposite to the middle of the cartilage-pit; muscular scars very large. *M. ponderosa*, Conr. Miocene; Maryland.

PSEUDOCARDIUM, Gabb, 1866.

Etym.—*Pseudo*, false, and *cardium*, a generic name.

Distr.—*Cardium Gabbi*, Remond. Miocene and Pliocene; California.

Shell thick, heavy, resembling *Lævicardium* externally; ligament internal; lunule cordate; left valve with a large cartilage-pit and a Λ-shaped tooth, which articulates in a corresponding depression in the right valve; two lateral teeth in each valve, very strong and prominent.

RANGIA, Desmoulins, 1832.

Syn.—Gnathodon, Rang, 1834. Clathrodon, Conr., 1837.

Distr.—1 sp. New Orleans. (3 other sp.? Mazatlan, California, Moreton B., Australia. Petit.) Fossil, 3 sp. Cret.—; Petersburg, Virginia.

Shell oval, ventricose; valves thick, smooth, eroded; epidermis olive; cartilage-pit central; hinge-teeth $\frac{2}{1}$; laterals doubled in the right valve, elongated, striated transversely; pallial sinus moderate.

Animal with the mantle freely open in front; margins plain; siphons short, partly united; foot very thick, tongue-shaped, pointed; gills unequal, the outer short and narrow; palpi large, triangular, pointed.

R. cyrenoides, Desm. (cix, 7), was formerly eaten by the Indians. At Mobile, on the Gulf of Mexico, it is found in colonies along with *Cyrena Carolinensis*, burrowing two inches deep in banks of mud; the water is only brackish, though there is a tide of three feet. Banks of dead shells, three or four feet thick, are found twenty miles inland. Mobile is built on one of these *ll*-banks. The road from New Orleans to Lake Ponchartrain

(six miles), is made of Gnathodon shells procured from the east end of the lake, where there is a mound of them a mile long, fifteen feet high, and twenty to sixty yards wide; in some places it is twenty feet above the level of the lake.—LYELL.

RANGIANELLA, Conr., 1867. Lateral teeth straight, subequal, not elongated, entire. The only sp. is *R. trigona*, Petit.

PERISSODON, Conrad. *P. clathrodonta*, Conr. Miocene.

SUBFAMILY *LUTRARIINÆ*.

Shell usually oblong or elongated, sometimes oval, gaping behind; lateral teeth very small, rudimentary, sometimes obsolete, and especially in adult or old shells.

LUTRARIA, Lamarck, 1799.

Otter's-shell.

Syn.—Mactra (partim), Linn. Lutricola (partim), Blainv. Psammophila, Leach, 1827.

Distr.—33 sp. United States, Brazil, Britain, Mediterranean, Senegal, Cape, India, New Zealand, Sitka. Fossil. Tertiary—; United States, Europe. *L. oblonga*, Gmel. (cix, 8).

Shell oblong, gaping at both ends; cartilage-plate prominent, with 1 or 2 small teeth in front of it, in each valve; pallial sinus deep, horizontal.

Animal with closed mantle-lobes; pedal opening moderate; foot rather large, compressed; siphons united, elongated, invested with epidermis; palpi rather narrow, their margins plain; gills tapering to the mouth.

Resembles Mya; burying vertically in sand or mud, especially of estuaries; low-water to 12 fathoms. *L. rugosa*, found living on the coasts of Portugal and Mogador, is fossil on the coast of Sussex, England.

DARINA, Gray, 1849. Shell oblong, compressed, rounded and a little gaping at each extremity; beaks subposterior; hinge with a large, spoon-shaped pit; lateral teeth very small, confounded with the cardinal tooth. Ligament separated from the pit by a lamella. *L. Solenoides*, King (cix, 9).

ZENATIA, Gray, 1849. (Metabola, Mayer.) Shell oblong, elongated, compressed; beaks not prominent, anterior, close; cardinal teeth distinct; lateral teeth none; ligament subexternal, marginal, not separated from the cartilage. *L. acinacies*, Quoy (cx, 11).

CÆCELLA, Gray, 1849. Shell oblong, subequilateral; cardinal tooth of the left valve large, triangular; lateral teeth very narrow, contiguous to the cardinal tooth; cartilage-pit projecting; ligament marginal. *L. turgida*, Desh. (cx, 12).

VANGANELLA, Gray, 1849. (Resania, Gray, 1849. Laminaria, Mayer. Myomactra, Mayer.) Valves with two interior diver-

ging ribs; cardinal teeth of the left valve close together, those of the right valve separated; lateral teeth small, thin, confounded with the cardinal pit; ligament subexternal, marginal, not separated by a lamella from the internal cartilage, which is lodged in a triangular, elongated, shallow pit. *L. lanceolata*, Gray (cx, 10).

ANATINELLA, G. Sowerby, 1829.

Distr.—3 sp. Ceylon, Philippines; sands at low-water. *A. candida*, Chemn. (cx, 13). *A. Sibbaldi*, Sowb. (cx, 14).

Shell ovate, rounded in front, attenuated and truncated behind; cartilage in a prominent spoon-shaped process, with 2 small teeth in front; muscular impressions irregular, the anterior elongated; pallial line slightly truncated behind.

CARDILIA, Deshayes, 1835.

Syn.—Hemicyclonosta, Deshayes.

Distr.—2 sp. Chinese Sea, Moluccas. Fossil, 2 sp. Eocene—; France, Piedmont. *C. Martinii*, Desh. (cx, 15). *C. semisulcata*, Lam. (cx, 16). *C. inermis*, Desh. (cx, 17).

Shell oblong, ventricose, cordate; beaks prominent, subspiral; hinge with a small tooth and dental pit in each valve; ligament partly internal, contained in a spoon-shaped inflection; anterior muscular scar long, with a pedal scar above; posterior adductor impression on a prominent subspiral plate; pallial line simple.

STROTHODON, Giebel. Right valve tumid, high like Cardilia, beaks incurved, with a groove running from the beaks to the posterior margin, hinge with a flat cardinal tooth and with a second tooth projecting from its base below and anteriorly. Only one valve known, from the Triassic beds of Liskau (Germany), *St. Liscaviensis*. It has the general appearance of a Cardilia, but the hinge differs, and as the teeth are flat, the upper one appears to indicate, by its form, that it had supported a cartilage. Giebel says that an external ligament is also present, but it must have been rather thin, for the fulcra are not perceptibly thickened.

HETEROCARDIA, Deshayes, 1854.

Distr.—3 sp. Philippines. *H. gibbosula*, Desh. (cx, 18).

Shell oval, subtrigonal, concentrically striate, gaping posteriorly; beaks small; hinge narrow; cardinal lamel a narrow, canaliculated; pallial impression with a very deep sinus, extending as far as the anterior muscular impression.

PTEROPSIS, Conrad, 1860.

Distr.—*P. papyria*, Conr. (cx, 19). Eocene; Ala., So. Carolina.

Shell thin, ovate, equivalve; hinge-plate very broad, with an ovate cartilage-pit; anterior cardinal tooth very large and

elevated, Λ-shaped, anterior to the pit, bifid and extending to the inner margin of the cardinal plate; posterior tooth long, elevated, compressed, oblique; posterior cardinal plate widely and profoundly channeled. The left valve only is known.

TRESUS, Gray, 1849.

Distr.—*T. maximus*, Midd. (cx, 20.) California.

Shell oval, oblong, ventricose, gaping posteriorly; cardinal tooth small, lateral teeth very small, connected with the cardinal; external marginal ligament separated from the cardinal pit by a lamina.

SCHIZOTHÆRUS, Conrad, 1852. Very closely allied to Tresus, with a deep channel on either side of the cardinal teeth. The terminations of the siphons are protected by two solid valves. *T. Nuttalli*, Conrad (cx, 21).

EASTONIA, Gray.

Distr.—*S. rugosa*, Gmel.

Shell thick, oval, radiately ribbed; cardinal tooth of the left valve compressed; anterior lateral tooth nearly perpendicular.

MEROPE, H. and A. Ad., 1852. Shell thinner, radiately striated or ribbed. *E. Ægyptica*, Chemn. (cx, 23).

LABIOSA, Schmidt, 1832.

Syn.—Cypricia, Gray. Leucoparia, Mayer.

Distr.—*L. lineata*, Say (cx, 24).

Shell oblong, widely gaping and reflected posteriorly; posterior slope narrow, defined by a carina; lateral teeth distinct, the anterior one oblique, near the cartilage-pit; ligament subexternal, marginal, not separated from the cartilage.

RÆTA, Gray, 1849. (Lovellia, Ch. Mayer.) Subcordate, ventri cose, thin, concentrically plicate, subangulate and gaping behind; cardinal tooth strong; posterior lateral tooth small. *L. canaliculata*, Say (cx, 25).

FAMILY PAPHIIDÆ.

Shell subtrigonal, equivalve, close; ligament lodged in an internal cardinal pit; cardinal teeth simple, compressed; lateral teeth rudimentary; siphons separate, divergent.

PAPHIA, Lamarck, 1799.

Syn.—Eryx, Sw. (not Daud.).

Distr.—31 sp. West Indies, Mediterranean, Crimea, India, New Zealand, Chili; sands at low-water. Fossil; Miocene—. *P. trigona*, Desh. (cx, 26).

Shell trigonal, thick, compressed, closed; ligament internal, in a deep central pit; a minute anterior hinge-tooth, and 1—1

lateral teeth in each valve; muscular scars deep; pallial sinus small.

Animal with mantle-margins plain; siphons short, thick and separate, orifices cirrated, branchial cirri dendritic; foot compressed, broadly lanceolate; gills large, unequal; palpi small.

MESODESMA, Desh., 1830. Shell oval, subequilateral; lateral teeth short, smooth, subequal; siphonal inflection distinct. *P. erycina*, Lam. (cx, 27).

TARIA, Gray. Shell oblong, subequilateral, attenuated posteriorly; posterior margin carinated; lateral teeth very narrow. *P. lata*, Desh. (cx, 28).

CERONIA, Gray, 1849. Shell oval, cuneiform; truncated behind; lateral teeth subequal, compressed, coarsely obliquely striate; siphonal inflection distinct. *P. Jauresii*, Joannis (cx, 29).

DONACILLA, Lam., 1812. Shell elongate-cuneiform, slightly truncate posteriorly; anterior lateral teeth elongated, posterior short; siphonal sinus distinct. *P. donacilla*, Lam. (cx, 30).

ANAPA, Gray, 1849. Shell subtrigonal, ventricose, truncate posteriorly; lateral teeth subequal, compressed, smooth; siphonal inflection obsolete. *P. cuneata*, Lam. (cx, 31).

DAVILLA, Gray, 1849. Shell cuneiform-orbicular, somewhat truncated posteriorly; lateral teeth unequal, the anterior narrow, perpendicular. *P. crassula*, Desh. (cx, 32).

MACTROPSIS, Conrad, 1865. Resembles Anapa; it has in the left valve either one bifid or two diverging cardinal teeth, a distinct anterior, but less prominent posterior lateral tooth; possesses a small obtusely angular pallial sinus; in external appearance it looks very much like a Crassatella. Eocene; N. Am. *P. Grayi*, Lea.

ERVILIA, Turton.

Etym.—Ervilia, diminutive of *ervum*, the bitter-vetch. Lentil-shell.

Distr.—2 sp. West Indies, Britain, Canaries, Mediterranean, Red Sea, W. Coast America; 50 fathoms. *E. castanea*, Mont. (cx, 33).

Shell minute, oval, close; cartilage in a central pit; right valve with a single prominent tooth in front and an obscure tooth behind; left valve with two obscure teeth; no lateral teeth; pallial sinus deep.

FAMILY SEMELIDÆ.

Shell thin, subequivalve, gaping and usually flexuous posteriorly; external ligament short; cartilage internal, in a cardinal pit. Siphons elongated, separate and divergent.

SEMELE, Schumacher, 1817.

Etym.—Semele, in Greek myth, the mother of Bacchus.

Syn.—Amphidesma, Lamarck, 1818.

Distr.—60 sp. West Indies, Brazil, India, China, Australia, Peru. Fossil, 30 sp. Eocene—; United States, Europe *S. variegata*, Lam. (cx, 34). *S. reticulata*, Chemn. (cx, 35).

Shell rounded, subequilateral, beaks turned forwards; posterior side slightly folded; hinge-teeth 2·2, laterals elongated, distinct in the right valve; external ligament short, cartilage internal, long, oblique; pallial sinus deep, rounded.

SYNDOSMYA, Recluz, 1843.

Syn.—Abra, Leach, MSS.

Distr.—Norway, Britain, Mediterranean, Black Sea, India. Fossil, 6 sp. Eocene—; Britain, France. *S. alba*, Wood (cx, 36). *S. brevis*, Desh. (cx, 37).

Shell small, oval, white and shining; posterior side shortest; umbones directed backwards; cartilage-process oblique; hinge-teeth minute or obsolete, laterals distinct; pallial sinus wide and shallow.

Animal with the mantle open, fringed; siphons long, slender, diverging, anal shortest, orifices plain; foot large, tongue-shaped, pointed; palpi triangular, nearly as large as the gills; branchiæ unequal, triangular.

The species are few, and mostly boreal, ranging from the laminarian zone to 180 fathoms.—FORBES. They live buried in sand and mud, but when confined are able to creep up the sides of the vessel with their foot.

THEORA, H. and A. Adams, 1854.

Syn.—Endopleura, A. Ad.

Distr.—4 sp. Eastern seas. *T. lata*, Hinds (cx, 38).

Shell compressed, transversely oval, smooth, polished, gaping behind; ligament lodged in the cardinal pit; pallial sinus profound.

A. Adams considers the species of Theora to be without primary teeth, which certainly is not always the case. He consequently suggests for a peculiar Chinese form with a "primary tooth in front of the oblique cartilage-pit" and "with an internal rib extending from the beaks obliquely towards the anterior side," the name Endopleura as a subgenus. The internal rib may be characteristic, but this is not the case as regards the presence of cardinal teeth.

The Theoræ live in mud and sometimes brackish water. The animal has a strongly compressed, linguiform foot, and two perfectly separated long siphons.

LEPTOMYA, A. Adams, 1864.

Distr.—2 sp. *L. cochlearis*, Hinds.

Shell thin, ventricose, beaked posteriorly; surface of valves

lamellar; hinge with an oblique cartilage-pit in each valve; right valve with two anterior primary teeth, left valve with a single primary tooth; lateral teeth none; pallial sinus deep.

LEIOMYA, A. Adams, 1864. Shell hyaline, hinge with two prominent lateral teeth; in other respects identical with Leptomya. *Neæra adunca*, Gould, is the type species.

SCROBICULARIA, Schumacher, 1817.

Syn.—Lavignon, Reaumur. Ligula, Mont. Listera, Turton. Mactromya, d'Orb.

Distr.—20 sp. Norway, Britain, Mediterranean, Senegal. Fossil, 4 sp. Tertiary; Europe. *S. piperata*, Gmel. (cx, 39; cxi, 41).

Shell oval, compressed, thin; subequilateral; ligament external, slight; cartilage-pit shallow, triangular; hinge-teeth small, one or two in each valve, laterals obsolete; pallial sinus wide and deep.

Animal with the mantle open, margins denticulated; siphons very long, slender, separate, orifices plain; foot large, tongue-shaped, compressed; palpi very large, triangular, gills minutely striated, the outer pair directed dorsally. Lives buried, vertically, in the mud of tidal estuaries, five or six inches deep.—MONTAGU. The siphons can be extended to five or six times the length of the shell.—DESHAYES. The animal has a peppery taste, but is sometimes eaten on the coasts of the Mediterranean.

LUTRICOLA (Blainv., 1824), Carpenter, 1865.

Syn.—Capsa (Bosc), H. and A. Adams.

Distr.—*L. Chemnitzii*, Desh. (cxi, 42).

Shell transversely elongately oval, cartilage-pit more vertical than oblique, cardinal tooth lamellar.

Lut. Chemnitzii, Desh., can be considersd as the type. H. and A. Adams refer to their subgenus *Capsa* also a few species, like *Tell. lacunosa*, Chemn., *T. spectabilis*, Hanley, and some others; these latter must form a subgenus in the Tellinidæ; they have a subinternal ligament, but not a cartilage.

IACRA, H. and A. Adams, 1858. Shell subtrigonal, somewhat attenuated and produced posteriorly, subpellucid, surface of the valve divaricately sulcated, cartilage-pit oblique, narrow; one cardinal tooth in each valve in front of the cartilage-pit; lateral teeth close to the cartilage-process, more prominent in the right than in the left valve. 4 sp. Red Sea, Ceylon, Seychelles, Japan.

ŒDALINA, Carpenter, 1866.

Distr.—*Œ. subdiaphana*, Carp. California.

Shell inflated, thin, equivalve, equilateral, rounded; scarcely gaping, ligament external, cartilage subexternal; hinge with

three cardinal teeth in one and two in the other valve; all bifid; no lateral teeth, pallial sinus deep.

COOPERELLA, Carpenter. Cartilage subinternal, the ligament contiguous to it, the cardinal teeth lamellar, simple or one of them bifid. This subgenus is perhaps allied to Metis, H. and A. Adams.

CUMINGIA, Sowb., 1833.

Dedicated to Hugh Cuming, a very distinguished collector of shells; his cabinet now belongs to the British Museum.

Distr.—10 sp. In sponges, sand, and the fissures of rocks; 7 fathoms. W. Indies, India, Australia, West America. Fossil. Miocene—; Wilmington, North Carolina. *C. mutica*, Sowb. (cx, 40).

Shell transversely oval, equivalve, rounded in front, subrostrated and slightly gaping behind, small, thin, often irregular in form; hinge with a spoon-shaped cartilage-pit, and a small anterior cardinal tooth in each valve; two elongated lateral teeth in the right valve, less developed in the left; beaks small; surface concentrically ridged; pallial sinus very wide.

MONTROUZIERA, Souverb., 1863.

Dedicated to a French conchologist resident in New Caledonia, and who has greatly contributed towards a knowledge of its shell-fauna.

Distr.—2 sp. New Caledonia, Mauritius. *M. clathrata*, Souverb. (cxi, 43–45).

Shell moderately elongated, hinge with the cartilage in a posteriorly directed groove, two cardinal teeth in front of it in the right valve, a single triangular, bifid one in the left; posterior, but quite close to the cartilage-pit, there is in each valve one short lateral tooth, looking, however, more like a posterior cardinal.

THYELLA, H. and A. Adams, 1865. Shell rather inflated, subtriangular, truncated posteriorly, surface decussated, striated; cartilage in an almost straight, projecting process; hinge in the right valve with two cardinal teeth, of which the anterior is bifid; in the left valve a single one bifid; no lateral teeth. *Th. pulchra*, from Singapore, is the only species as yet known.

FAMILY TELLINIDÆ.

Shell free, compressed, usually closed and equivalve; cardinal teeth 2 at most, laterals 1—1, sometimes obsolete; muscular impressions rounded, polished; pallial sinus very large; ligament on shortest side of the shell, external. Structure obscurely prismatic-cellular; prisms fusiform, nearly parallel with surface, radiating from the hinge in the outer layer, transverse in the inner.

Animal with the mantle widely open in front, its margins fringed; foot tongue-shaped, compressed; siphons separate, usually very long and slender; palpi large, triangular; gills united posteriorly, unequal, the outer pair sometimes directed dorsally.

The Tellens are found in all seas, chiefly in the littoral and laminarian zones; they frequent sandy bottoms, or sandy mud, burying beneath the surface; a few species inhabit estuaries and rivers. Their valves are often richly colored and ornamented with finely sculptured lines.

SUBFAMILY *TELLININÆ.*

Shell oval or wide, sometimes slightly gaping posteriorly; ligament external, prominent. Siphons elongated.

ASAPHIS, Modeer, 1793.

Syn.—Capsula, Schum., 1817. Capsa (part), Brug., 1791. Sanguinolaria, Lam., 1818, not 1801. Pliorhytis, Conrad.

Distr.—5 sp. West Indies, Red Sea, India, China, Australia. Fossil. Eocene—; United States, Europe. *A. deflorata*, Linn. (cxi, 55).

Shell oblong, ventricose, slightly gaping at each end; radiately striated; cardinal teeth 2 in each valve, one of them bifid; ligament external, large, prominent; siphonal inflection short.

Animal like Psammobia; foot moderate; gills deeply plaited, attenuated in front, outer small, dorsal border wide, fixed; siphons moderate.

GARI, Schumacher, 1817.

Syn.—Psammobia, Lam., 1818. Sanguinolaria, Roissy, 1805. Lutricola (partim), Blainv., 1824. Psammosolen, Bronn, 1831.

Distr.—80 sp. Norway, Britain, India, New Zealand, Pacific; littoral—coralline zone, 100 fathoms. *G. gari* is eaten in India. Fossil, 55 sp. Cretaceous—; United States, Europe. *G. insignis*, Desh. (cxi, 46). *G. vespertina*, Chemn. (cxi, 68).

Shell transverse, oval-oblong, flat, equivalve, subequilateral, concentrically plicate, a little gaping on each side and covered by a thin epidermis; hinge narrow, with two small cardinal teeth, sometimes bifid, in each valve; beaks small; ligament long and prominent; margins simple; muscular impressions rather large, equally distant from the hinge, the anterior oblong, the posterior rounded; pallial impression distant from the margin, with a narrow, profound sinus.

Animal: mantle open, fringed; siphons very long, slender, nearly equal, longitudinally ciliated, orifices with 6–8 cirri; foot large, tongue-shaped; palpi long, tapering; gills unequal, recumbent, few-plaited.

The genus commenced in the cretaceous period, augmented during the tertiary, and is at its greatest development now.

PSAMMOCOLA, Blainv., 1824. Shell oblong, subquadrangular; surface smooth. *G. maxima*, Desh. (cxi, 47).

AMPHICHÆNA, Philippi, 1847. (Psammobella, Gray, 1851.) Shell oblong, gaping at both extremities; posterior end rounded. *G. modesta*, Desh. (cxi, 48).

HETEROGLYPTA, Martens, 1880. Posterior portion of the shell differently sculptured. *G. squamosa*, Lam.

SANGUINOLARIA, Lamarck, 1799.

Etym.—From the type, *Solen sanguinolentus*, Chemn.

Syn.—Lobaria, Schum., 1817.

Distr.—5 sp. *S. rosea*, Lam. (cxi, 49). Fossil; ? Paleozoic—.

Shell transverse, subelliptical, flattened, equivalve, inequilateral, a little gaping at the ends, not angulate posteriorly, covered by a thin, fugacious epidermis; hinge having two small, unequal, divergent cardinal teeth in each valve, the anterior of the left valve and posterior of the right valve being the largest; beaks small; ligament long; margins plain; muscular impressions subdorsal, the anterior oval, posterior circular; pallial impression elongated, with a shallow, narrow sinus.

HIATULA, Modeer, 1793.

Syn.—Soletellina, Blainv., 1824.

Distr.—40 sp. W. Indies, Red Sea, India, Madagascar, Japan, Australia, Tasmania, Peru. Fossil, 30 sp. Eocene—; U. S., Europe. *H. diphos*, Linn. (cxi, 50).

Valves oval-oblong, compressed, ventral margin usually incurved posteriorly, where the valves are attenuated; broadly rounded anteriorly; beaks submedian, not prominent; violaceous, under an olive epidermis; ligament thick, swollen; one or two very small cardinal teeth in each valve; muscular impressions rounded, distant; pallial impression very sinuous.

PSAMMOTÆA, Lam., 1818. Posterior slope a little angulated, but not rostrated. *H. violacea*, Lam. (cxi, 51).

PSAMMOTELLA, Blainv., 1826. Shell thin, oval or oblong, posterior edge rounded. *H. elongata*, Lam. (cxi, 52).

ELIZIA, Gray, 1852.

Distr.—2 sp. East Indies. *E. orbiculata*, Wood (cxi, 53, 54).

Shell suborbicular, equivalve, thin, compressed, covered by a shining epidermis; beaks not prominent, subanterior; hinge with two oblique cardinal teeth in the right valve, one of which is elongated and bifid, and three teeth in the left valve, the central one bifid; pallial impression submarginal.

TELLINA, Linn., 1758.

Etym.—*Telline*, the Greek name for a kind of mussel.

Distr.—Above 300 sp. In all seas, especially the Indian Ocean; most abundant and highly colored in the tropics. Low-water—coral zone, fifty fathoms. Wellington Channel, Kara Sea, Behring's Straits, Baltic, Black Sea. Fossil, 170 sp. Oolitic—; United States, South America (Chiloe), Europe. *T. rastellum*, Hanley (cxi, 56).

Shell slightly inequivalve, compressed, rounded in front, angular and slightly folded posteriorly, umbones subcentral; teeth 2·2, laterals 1—1, most distinct in the right valve; pallial sinus very wide and deep; ligament external, prominent.

Animal with slender, diverging siphons, twice as long as the shell, their orifices plain; foot broad, pointed, compressed; palpi very large, triangular; gills small, soft and very minutely striated, the outer rudimental and directed dorsally.

TELLINELLA, Gray, 1852. Shell oblong, elongated, posteriorly rostrated or subrostrated; hinge with two lateral teeth in one valve. *T. virgata*, Linn.

PERONÆODERMA, Poli, 1795. Shell oval, compressed, posteriorly subangular; hinge with two lateral teeth in one valve. *T. punicea*, Born (cxi, 57). Not very distinct from Tellinella.

MŒRA, H. and A. Adams, 1852. (Donacilla, Gray, 1851.) Shell oblong, Donaciform; posteriorly short, cuneiform, truncate; two lateral teeth in one valve. *T. donacina*, Linn. (cxi, 58–60).

PALÆOMŒRA, Stoliczk., 1870. Shell elongated, hinder part shorter, the upper declivity slightly convex, posterior end subtruncate, beaks directed forwards; ligament situated on thickened but not prominent fulcra; hinge with one anterior, long, lamelliform tooth in each valve, bifid in the right, single in the left valve, posterior cardinal tooth not distinctly traceable in either valve; laterals less distinct in the left valve. This is based upon the cretaceous *Tellina strigata* of Goldfuss. In form it very much resembles Mœra, but the hinge presents some marked differences, as noted above.

LINEARIA, Conrad, 1860. (Liothyris, Conr.) Shell elongated, sometimes roundish, not peculiarly thick, rounded on both ends, surface partially or wholly radiately ribbed, posteriorly not, or very indistinctly flexuous; anterior cardinal teeth on both valves elongated, bifid, much smaller in the left valve; posterior cardinal small, but larger in the left than in the right; lateral teeth much thinner in the left than in the right valve, sometimes almost obsolete in the former. This ought to include a large number of fossil species which have been described as Arcopagiæ; the want of posterior flexure or plicature and the usual radiate ribbings near the terminations of the shell particularly characterize

those species. Among recent shells they are represented by *Tell. concentrica*, Gould (not *id.* Reuss or d'Orb.), and one or two others. For many years palæontologists have separated these shells from Tellina and applied to them the name of Arcopagia. *T. metastriata*, Conr. (cxi, 61).

ARCOPAGIA, Leach, 1827. Shell rounded-oval or orbicular; two lateral teeth in one valve. *T. fausta*, Donov. (cxi, 62).

PHYLLODA, Schum., 1817. Shell oblong, much compressed, posteriorly angular and carinated; cardinal teeth divergent, sublamellar. *T. foliacea*, Linn. (cxi, 63).

ANGULUS, Schum., 1817. (Tellinula, Chemn. Fabulina, Gray, 1851.) Shell oblong, subtriangular, compressed; anteriorly rounded, posteriorly more or less pointed or angulated; a single lateral tooth in one valve. *T. polita*, Say (cxi, 64, 65).

TELLINIMERA, Conrad, 1860. (Tellimera, Conr., 1870.) Shell thin, elongated, subtriangular; right valve with three cardinal teeth, the shortest extending to the apex; left valve with two cardinal teeth, the posterior one bifid; no lateral teeth. Closely related to Angulus in form. *T. eborea*, Conr. (cxii, 100). Cret.; U. S.

TELLINIDES, Lamarck, 1818. Shell oval, compressed, slightly flexuous posteriorly; hinge with a single lateral tooth, contiguous to the cardinals. *T. Timorensis*, Lam. (cxi, 66).

HOMALINA, Stoliczka, 1870. (Homala, H. and A. Adams, not Schum.) Shell oblong, compressed, inequivalve, inequilateral, anteriorly short, rounded; posteriorly flexuous, obsoletely carinate, somewhat produced, narrowed; one lateral tooth near the hinge. *T. triangularis*, Chemn. (cxii, 99).

PERONÆA, Poli, 1791. (Omala, Schum., 1817.) Shell oblong, oval; anteriorly short, rounded, posteriorly somewhat flexuous, subangulate; lateral teeth obsolete. *T. planata*, Linn. (cxi, 67).

METIS, H. and A. Adams. Shell suborbicular, compressed, valves sillonated, posterior flexuosity submedian; no lateral teeth. *T. Meyeri*, Phil. (cxii, 69).

ÆNONA, Conrad, 1870. Shell subtriangular, inequilateral, hinge-margins equally declined, beaks not prominent, lunule very narrow, lanceolate, marked by a deeply impressed line; two very small, widely diverging cardinal teeth in the right valve, one bifid and one rudimentary tooth in the left valve. *T. Eufalensis*, Conrad (cxii, 70). Cretaceous; U. S.

[MACTROMYA, Agassiz, 1842. This group, which I have placed in Anatinidæ (p. 149), Stoliczka classifies as a distinct genus of Tellinidæ. Zittel refers species of Mactromya to several groups in Tellinidæ and Paphiidæ.]

ARCOPAGELLA, Meek.

Distr.—2 sp. Cretaceous; U. S. *A. Mactroides*, Meek (cxii, 6).

Shell equivalve, more or less equilateral, longer than high, with margins closed all around and smooth within. Hinge with two cardinal and one anterior and one posterior lateral teeth in each valve. Left valve with anterior cardinal tooth larger than the posterior, and trigonal in form, but sometimes rather deeply emarginated below, placed directly under the beak; posterior cardinal tooth small, slender, and ranging obliquely backward and downward close to the larger one, so as to leave only a slender pit between, corresponding to another on the anterior side of the principal cardinal tooth, which two pits are for the reception of the cardinal teeth of the right valve; anterior and posterior lateral teeth both elongated parallel to the cardinal margin, the former approaching more nearly to the cardinal teeth. Right valve with, under the apex, two diverging, slender, cardinal teeth, like the posterior one of the other valve, with a triangular pit between them for the reception of the principal cardinal tooth of the left valve; anterior one more oblique than the other, and nearly or quite connecting with the lateral tooth on that side; lateral teeth like those of the left valve; the anterior one apparently fitting under and the posterior above that of the other valve. Muscular impressions shallow; pallial impression with a moderate rounded sinus, directed obliquely forward and upward. Ligament unknown, but believed to be external. Surface without ornamentation.

STRIGILLA, Turton, 1822.

Distr.—17 sp. W. Ind., Panama, Polynesia, etc. Fossil; Tertiary. *S. carnaria*, Linn. (cxii, 71–73).

Shell orbicular, somewhat convex; surface with diverging striæ; no posterior flexure or carina; right valve with a large bifid cardinal tooth, left valve with a smaller, simple tooth; two lateral teeth in each valve; pallial sinus angular, profound.

MACOMA, Leach, 1819.

Syn.—Rexithærus, Conr.

Distr.—85 sp. World-wide. Fossil; Tertiary. *M. umbonella*, Lam. (cxii, 74).

Shell oval or subrotund, convex; cardinal teeth narrow; no lateral teeth; pallial impression with a profound sinus.

Animal with a single branchial lamella on each side. "The branchial apparatus," says Clark, "is curious, and a departure from the Tellina type; it consists of a single, rather elongated branchial plate on each side, situated towards the posterior half of the animal; it is fixed to the dorsal range by its base running obliquely, indeed almost vertically, from the dorsal to the ventral range, becoming joined to its fellow under the posterior and smaller part of the body by a permanent membrane." The palpi are very large and triangular.

TELLIDORA, Mörch, 1851.

Distr.—2 sp. W. Coast of Central America. Fossil, 1 sp. Pleistocene; So. Carolina. *T. Burnettii*, Brod. (cxii, 75).

Shell subtriangular, rounded below, very inequivalve, right valve concave, left valve slightly convex; concentrically plicate, the plicæ forming teeth on the lateral margins; beaks angular, inclined anteriorly; two cardinal teeth in one valve, one in the other; two lateral teeth in each valve.

GASTRANA, Schumacher, 1817.

Syn.—Fragilia, Desh., 1848. Diodonta, Desh.

Distr.—5 sp. Norway, Britain, Mediterranean, Black Sea, Senegal, Cape. *G. fragilis*, Linn. (cxii, 76, 77). Fossil. Miocene—; Britain, France, Belgium.

Shell equivalve, convex, with squamose lines of growth; cardinal teeth two in right valve, one bifid tooth in left; pallial sinus deep and rounded; umbonal area punctate; ligament external.

Animal with the mantle open in front, its margins fringed; siphons elongated, slender, separate, unequal, orifices with cirri; foot small, compressed, linguiform; palpi large, triangular; gills unequal, soft, finely striated.

Gastrana inhabits shallow water, boring in mud and clay, and not traveling about like the Tellens.

MACALIA, A. Adams, 1860.

Distr.—*M. inquinata*, Desh. (cxii, 78).

Shell suborbicular, rather solid and inflated, posteriorly with a moderate ridge, nearly equivalve; the beaks are prominent, the ligament situated in a deep groove; the hinge with two very strong cardinal teeth in each valve.

QUENSTEDTIA, Morris and Lycett, 1853.

Dedicated to Prof. Quenstedt, palæontologist, of Würtemburg.

Syn.—Arcomya and Mactromya (in part), Agassiz.

Distr.—3 sp. Oolitic; England, France, Germany. *Q. oblita*, Phil. (cxii, 98).

Shell oblong, equivalve, moderately solid, umbones nearly contiguous, hinge with a transverse cardinal tooth in the left, and a corresponding pit in the right valve; ligament external, placed in a long, narrow groove, pallial sinus small.

Only a few Jurassic species have as yet been referred to this genus; its systemic position is doubtful.

LUCINOPSIS, Forbes and Hanley, 1848.

Syn.—Lajonkairia, Desh. Mysia, Gray.

Distr.—6 sp. Europe, W. Indies, W. Coast of South America. *L. undata*, Pennant (cxii, 79).

Shell compressed, thin, suborbicular, two divergent, lamellar teeth in the right valve, three in the left valve, the middle one bifid; muscular impressions oval, polished; pallial line with a profound, ascending sinus.

Mantle-margins plain, pedal opening contracted; foot basal, pointed.

SUBFAMILY *DONACINÆ*.

Shell close, triangular, wedge-shaped, usually thick; ligament short.

Siphons short, separate, divergent.

DONAX, Linn., 1758.

Etym.—*Donax*, a sea-fish. (Pliny.) Wedge-shell.

Syn.—Chione, Scop. Cuneus, Da Costa, 1778. Capisterium, Meuschen.

Distr.—100 sp. United States, Norway, Baltic, Black Sea, all tropical seas. In sands near low-water mark (—8 fathoms), buried an inch or two beneath the surface. Fossil, 45 sp. Cret.—; United States, Europe. *D. denticulatus*, Linn. (cxii, 80, 81).

Shell trigonal, wedge-like, closed; front produced, rounded; posterior side short, straight; margins usually crenulated; hinge-teeth 2·2; laterals 1—1 in each valve; ligament external, prominent; pallial sinus deep, horizontal.

Animal with the mantle fringed; siphons short and thick, diverging, anal orifice denticulated, branchial with pinnate cirri; foot very large, pointed, sharp-edged, projected quite in front; gills ample, recumbent, outer shortest; palpi small, pointed.

LATONA, Schum., 1817. Shell oval, cuneiform, compressed behind, truncated in front; margin simple within. *D. cuneatus*, Linn. (cxii, 82).

HECUBA, Schum., 1817. Shell triangular, subcordiform; anterior side sharply angulated, flattened, produced; two lateral teeth in each valve. *D. scortum*, Linn. (cxii, 83, 85).

SERRULA, Chemn. Shell oval-triangular, cuneiform, gibbous in front; margins denticulated within; hinge with oblong cartilage-fissure. *D. trunculus*, Linn. (cxii, 86).

CAPSELLA, Gray. Shell oval-oblong, transversely elongated, subrounded at the extremities; covered with a greenish epidermis; margins of valves smooth within. *D. acutangulus*, Desh.

HETERODONAX, Mörch. Shell rounded-triangular, smooth, rather solid; two lateral teeth in each valve. *D. ovalinus*, Desh. (cxii, 87).

EGERELLA, Stoliczka, 1870. (Egeria, Lea, 1833, not Roissy or Leach.) Shell elongated, subtrigonal, anterior side much shorter than posterior; hinge with two cardinal teeth in each valve, one of which is bifid, lateral teeth none, sometimes they are indicated

by a thickening of the margins; ligament external, apparently on the shorter side, inner edge of shell occasionally crenated. Lea described several somewhat different species under this genus. Conrad referred the orbicular forms to Mysia and Sphærella, and *they* certainly belong to the Lucinidæ, reserving the name Egeria for such forms as *Eg. subtrigona* (cxii, 90) and *ovalis* of Lea. These shells externally very much resemble the subgenus Mœra of Tellina, but as the latter never have the inner margin crenated, it is probable that the present classification of the group is the more correct one. Conrad, in his Check List of Eocene North American Fossils (1866), refers seven species to the group. Deshayes and others describe similar tertiary forms.

ONCOPHORA, Rzehak, 1882. Founded upon *O. socialis*, Rzeh., a tertiary fossil, supposed to have inhabited brackish water. (Verh. K. K. Geol. Reichs., No. 3, 41, 1882.)

IPHIGENIA, Schumacher, 1817.

Syn.—Capsa, Lam., 1818. Donacina, Fer.

Distr.—5 sp. West Indies, Brazil, West Africa, Pacific, Cen. America. *I. Brasiliensis*, Lam. (cxii, 88). Inhabits estuaries. *I. ventricosa*, Desh., has eroded beaks.

Shell transverse, subequilateral, gibbous, covered with a thin olivaceous epidermis; hinge-teeth 2·2, one bifid, the other minute; laterals remote, obsolete in the left valve; margins smooth.

FISCHERIA, Bernardi, 1859.

Etym.—Dedicated to Dr. Paul Fischer, one of the able editors of the Journal de Conchyliologie.

Distr.—2 sp. *F. Delesserti*, Bern. (cxii, 89). Africa.

Shell transverse, equivalve, subequilateral, close, rather thick, with epidermis; right valve with a median, longitudinally channeled cardinal tooth, with additional rudimentary cardinals; left valve with a median pit (to receive the cardinal of the other valve), and two slightly oblique, lateral cardinals; right valve with extremely thin, compressed lateral teeth, none in the left valve; muscular impressions distinct, pallial sinus large and deep; ligament short, rather elevated.

GALATEA, Bruguiere, 1792.

Syn.—Egeria, Roissy, 1805. Potamophila, Sowerby, 1822. Megadesma, Bowdich, 1823. Galateola, Fleming, 1828.

Distr.—16 sp. Nile, and rivers of West Africa. *G. radiata*, Lam. (cxii, 91). *G. reclusa*, Born (cxii, 92).

Shell very thick, trigonal, wedge-shaped; epidermis smooth, olive; umbones eroded; hinge thick, teeth 1·2, laterals indistinct; ligament external, prominent; pallial sinus distinct.

Animal with the mantle open in front; siphons moderate, with 6–8 lines of cilia, orifices fringed; foot large, compressed; palpi

long, triangular; gills unequal, united to the base of the siphons, the external pair divided into two nearly equal areas by a longitudinal furrow, indicating their line of attachment.

SOWERBYA, d'Orbigny, 1850.

Etym.—Dedicated to Sowerby, author of "British Mineral Conchology," etc. *Syn.*—Isodonta, Buvignier, 1851.

Distr.—Fossil, 8 sp. Lower Lias—Portlandian; England, France, Germany. *S. Deshayesii*, Buv. (cxii, 93).

Shell equivalve, subequilateral; right valve with two oblique, diverging, cardinal teeth separated by a mesial trigonal socket, and two lamellar lateral teeth, separated from the hinge-border by longitudinal grooves; left valve with a conical tooth between two oblique pits; laterals two, longitudinal lamellar and projecting, and united to the superior border; ligament external.

FAMILY PETRICOLIDÆ.

Shell gaping, free, but frequently perforating clay or soft rocks, and therefore often irregular in form; white under a very thin epidermis; hinge narrow, bidentate in each valve; sinus of the pallial impression profound.

Animal with the mantle closed in front, much thickened and recurved over the edges of the shell; pedal opening small; foot small, pointed, lanceolate; siphons partially separate, orifices fringed, anal with a valve and simple cirri, branchial cirri pinnate; palpi small, triangular.

PETRICOLA, Lamarck, 1801.

Etym.—*Petra*, stone; *colo*, to inhabit.

Syn.—Choristodon, Jonas (in part).

Distr.—13 sp. United States, France, Red Sea, India, New Zealand, Pacific, West America (Sitka—Peru). Burrows in limestone and mud. Fossil, 20 sp. Cretaceous, Eocene—; United States, Europe.

Shell oval or elongated, thin, tumid, anterior side short; hinge with three teeth in each valve, the external often obsolete; pallial sinus deep.

PETRICOLARIA, Stoliczka, 1870. For the transversely elongated forms, of which *P. pholadiformis*, Lam. (cxii, 94), is the type. This species is very common, perforating clay or mud upon the sandy beaches of New Jersey.

RUPELLARIA, Fl. de Bellevue, 1802.

Syn.—Venerupis, Lam., 1818.

Distr.—30 sp. Europe, Pacific, etc. Fossil; Jurassic—. *R. foliacea*, Desh. (cvii, 96).

Shell elongated, moderately tumid, surface rugosely striated

and ribbed, distinctly gaping posteriorly; hinge in the right valve with two cardinal teeth, and a third very small, but usually obsolete, anterior; the middle one is prominent, curved as in Petricola; the posterior is longitudinally lamellar, low and bifurcate; in the left valve are three distant and very unequal cardinal teeth; the middle one is similarly projecting as the corresponding tooth in the other valve. *Rup. lamellifera*, Conrad, may be considered as a type of the group.

Choristodon (Jonas, 1844), H. and Adams, 1857.

Syn.—Naranio, Gray, 1853.

Distr.—3 sp. Polynesia, Mazatlan. *C. divaricatum*, Chemn. (cxii, 94).

Shell oval-quadrangular, rugose or tuberculose, swollen, beaks anterior; two cardinal teeth in each valve, the superior one of the right valve compressed and elongated, that of the left valve oblique and bifid; no lateral teeth; ligament external, short, in a deep groove; anterior muscular impression oblong, posterior one large, rounded; pallial sinus rounded, deep.

Saxidomus, Conrad, 1837.

Distr.—Californian Province. *S. Nuttallii*, Conrad (cxii, 97).

Shell transversely oval, inequilateral, solid, ventricose, without lunule, umbones tumid; teeth three or four, unequal, narrow, the central bifid; ligament very thick, elongated; muscular impressions oval or rounded, nearly equal; pallial sinus large, elongated, horizontal.

Family VENERIDÆ.

Shell regular, closed, suborbicular, or oblong; ligament external; hinge with usually three diverging teeth in each valve; muscular impressions oval, polished; pallial line sinuated.

Animal free, locomotive, rarely byssiferous or burrowing; mantle with a rather large anterior opening; siphons unequal, united more or less; foot linguiform, compressed, sometimes grooved; palpi moderate, triangular, pointed; branchia large, subquadrate, united posteriorly.

The shells of this tribe are remarkable for the elegance of their forms and colors; they are frequently ornamented with chevron-shaped lines. Their texture is very hard, all traces of structure being usually obliterated. The Veneridæ appeared first in the Oolitic period, and have attained their greatest development at the present time; they are found in all seas, but most abundantly in the tropics.

Subfamily *VENERINÆ.*

Shell oval or subtrigonal. Siphons free to their extremity; foot lanceolate, without byssiferous groove.

VENUS, Linn.

Syn.—Antigona, Schum., 1817.

Distr.—176 sp. World-wide. Low-water—140 fathoms. *V. astartoides*, Behring's Sea. *V. verrucosa*, Britain, Mediterranean, Senegal, Cape, Red Sea, Australia? Fossil, 200 sp. Oolite—: Patagonia, United States, Europe, India. *V. verrucosa*, Linn. (cxiii, 7, 8). *V. puerpera*, Linn. (cxiii, 9).

Shell thick, ovate, smooth, sulcated, or cancellated; margins minutely crenulated; cardinal teeth 3—3; pallial sinus small, angular; ligament prominent; lunule distinct.

Animal with mantle-margins fringed; siphons unequal, more or less separate; branchial orifice sometimes doubly fringed, the outer pinnate; anal orifice with a simple fringe and tubular valve; foot tongue-shaped; palpi small, lanceolate.

MERCENARIA, Schum., 1817. (Crassivenus, Perkins, 1869.) Shell thick, ventricose, cordiform; margins crenulated within; three compressed, diverging teeth in each valve, the posterior of the right valve and anterior of the left valve strong and slightly bifid, the others lamellar; pallial sinus subtriangular. An American group, containing some of the largest and heaviest species of the genus. *V. tridacnoides*, a fossil of the United States, has massive valves, ribbed like the clam-shell. The North American Indians used to make coinage (wampum) of fragments of *Venus mercenaria* (cxiii, 10–12) by perforating and stringing them on leather thongs; this is the edible hard-shell clam largely consumed on and near the coast of the United States.

CRYPTOGRAMMA, Mörch, 1853. (Anomalocardia, Schum., 1817. Triquetra, Blainv., 1818.) Shell ventricose, triangular, prolonged, flexuous and attenuated posteriorly; hinge with three cardinal teeth in each valve, the anterior one of the right valve small; margins crenulated. *V. macrodon*, Lam. (cxiii, 13). *V. squamosa*, Linn. (cxiv, 30).

CHIONE, Megerle, 1811. (Murcia, Römer, 1867. Omphaloclathrum, Klein.) Shell oval, triangular or subcordiform; margins finely crenulated; hinge narrow, solid, with three teeth in the right valve and two in the left, the anterior tooth longest; ligament narrow; pallial sinus shallow. Mantle-margins folded and dentate; siphons short, unequal, the branchial doubly cirrated, the anal ciliated. *V. gnidia*, Brod. (cxiii, 14).

CIRCUMPHALUS, Klein, 1753. Surface of the valves lamellar. *V. plicata*, Gmel. (cxiii, 15, 16).

TIMOCLEA, Leach, Brown, 1827. (Leucoma, Römer, 1867.) Surface decussately striate. *V. grata*, Say.

CHAMELÆA, Klein, 1753. Surface concentrically striate. *V. aphrodinoides*, Reeve (cxiii, 17).

VENTRICOLA, Römer, 1867. Surface concentrically lamellate. *V. rugosa*, Chemn.

MARCIA, H. and A. Adams, 1854. Surface of the valves smooth. *V. undulosa*, Lam. (cxiii, 18).

KATELYSIA, Römer, 1857. *V. scalarina*, Lam.

ANAITIS, Römer, 1857. (Clausina, Brown.) Includes the moderately tumid cordate forms with strong concentric lamellæ. *V. plicata*, Gmel.

GOMPHINA, Mörch, 1855. Shell ovate, cordate, moderately inflated, smooth; hinge-teeth the same as in typical Chione. Römer describes four species, and considers *V. undulosa*, Lam., as the type, while H. and A. Adams quote *V. donacina*, Chemn. (cxiii, 19), as the only species, and place it as a subgenus of Cytherea (= Meretrix).

VOLUPIA, Defrance, 1829. Shell minute, Isocardia-shaped concentrically ribbed, with a large lunule. *V. rugosa*, Defr. Eocene; Hauteville.

PSEPHIS, Carpenter, 1865.

Distr.—3 sp. California. *P. Lordi*, Carp.

Shell thin, rounded or quadrangular, somewhat inflated; pallial sinus small; three elongated thin cardinal teeth in each valve. Oviparous, like Sphærium.

CYTHEREA, Lam., 1805.

Etym.—*Cytherea*, from Cythera, an Ægean island.

Syn.—Meretrix, Lam., 1799. Callistoderma, Poli, 1791. Corbicula, Benson.

Distr.—Same as Venus. Recent 150 sp. Fossil, 80 sp. Cretaceous—. *C. petechialis*, Lam. (cxiii, 20).

Shell like Venus, oval-triangular, smooth; margins simple; hinge with three cardinal teeth and an anterior tooth beneath the lunule; pallial sinus moderate, angular.

Animal with plain mantle-margins; siphons united half-way.

CALLISTA, Poli, 1791. Shell oval, transverse, inequilateral; pallial sinus suboval, profound. Mantle-margins folded and cirrous above the siphons; siphons united, cirrated at their extremities. *C. erycina*, Linn. (cxiii, 21).

TIVELA, Link, 1807. (Trigona, Muhlf., 1811.) Shell triangular, subequilateral, cuneiform; three to five cardinal teeth in one valve, four to six in the other; anterior lateral tooth narrow, elongated, compressed; pallial impression with a short oblique or sometimes horizontal sinus. 28 sp. W. Indies, Mediterranean, Senegal, Cape, India, West America. Fossil. Miocene; Bordeaux. *C. radiata*, Sowb. (cxiii, 22).

PACHYDESMA, Conr. (Trigonella, Conr., 1837.) *C. crassatelloides*, Conr., attains a diameter of five inches, and is very ponderous.

APHRODINA, Conrad, 1868. Shell rounded or suboval, striated or sulcated; hinge in the left valve with three diverging cardinal

teeth, the anterior as thick as the middle one, or thicker, and a straight, compressed, transversely rugose lateral tooth parallel with the margin above it; pallial sinus deep, and similar to that in Caryatis, Römer. *C. Tippana*, Conr. Cretaceous; U. S. Too closely allied to the next group.

CARYATIS, Römer, 1862. (Olim *Pitar*, Röm., 1857.) Shell cordate or subtrigonally ovate, usually of moderate thickness and somewhat inflated, white or yellowish brown colored, concentrically finely striated, pallial sinus always distinct, triangular or obtuse. *Venus tumens*, Gmelin, is the type of this very well-marked form of Cytherea; its distinction from others is of great importance in fossil conchology, for to it mostly appear to belong the oldest representants of the genus; of recent species, Römer describes sixty, and adds two doubtful ones. *C. Alcyone*, Römer (cxiv, 36, 37).

DOSINIOPSIS, Conrad, 1864. Shell exteriorly like Dosinia. Cardinal teeth three in each valve; posterior tooth of right valve bifid; in the left valve, a thick rugose lateral tooth fitting into a cavity in the opposite valve; under the umbo is a pit; cartilage-plate granulated; pallial sinus deep and angular. 3 sp. Eocene; United States. *C. lenticularis*, Rogers (cxv, 38).

DIONE, Gray, 1847. Shell moderately compressed, always concentrically densely sulcated, and with a more or less distinct ridge running from the beaks in an easy curve to the infero-posterior margin; this ridge is sometimes provided with spines; pallial sinus moderate, always distinct, usually linguiform. The type is *Venus dione*, Linn. Römer notices 13 sp. *C. lupanaria*, Desh. (cxiii, 23).

AMIANTIS, Carp., 1865. Type, *Cytherea callosa*, Con. This group certainly does not deserve to bear a special name. It only differs by having the fulcra thicker than most other species, and rugose. The general form and dentition of the hinge are extremely like *Cyth. (Callista) erycina*, Linn.

MACROCALLISTA, Meek. Shell transversely elongate-oval, with surface smooth; pallial sinus and hinge nearly typical, excepting that the sublunular or anterior lateral tooth is generally more compressed, more oblique, and more remote from the cardinal, and the posterior lateral much more elongated, and nearly horizontal. *Venus gigantea*, Gmelin.

ARTENIA, Conrad, 1870. Shell triangular, thick; surface with acute, concentric, prominent ribs; hinge with three cardinal teeth in the right valve, two of them diverging, distant, the anterior one under the apex robust, direct, curved; left valve with three diverging distant teeth; lateral tooth very small, pyramidal; pallial sinus very small and angular. *Cytherea staminea*, Con. (cxiv, 31). Tert.; U. S. This appears to be very close to some species of Dione.

GOULDIA, C. B. Ad., 1847. (Lioconcha, Mörch, 1853. Thetis, Ads., 1845.) Shell subtrigonal, oval, smooth, shining, inflated. *C. cerina*, Ads. (cxxiii, 66).

CIRCE, Schum., 1817. Shell rounded or oval; beaks flattened; surface concentrically sculptured; inner margin simple, or sometimes crenulated; middle cardinal teeth much stronger than the others; pallial impression truncated, but not sinuated posteriorly. *C. divaricata*, Chemn. (cxiii, 25).

CRISTA, Römer, 1857. Cordate or transversely ovate, solid, tumid, with radiating ribs or divaricating striæ; pallial sinus very small; internal margin crenated; ligament in a groove, but distinctly visible outside. *C. pectinata*, Linn. (cxiii, 26, 27).

SUBFAMILY *MEROËINÆ*.

Shell ovately elongated, moderately compressed; hinge with three or four compressed cardinal teeth, and one long lunular in each valve; the posterior margin behind the beaks is peculiarly flexured and bent inside, forming a deep cavity, sometimes with corrugated sides and containing the ligament hidden or almost hidden; lunule linear; pallial sinus distinct.

MEROË, Schum., 1817.

Etym.—Meroë, an island of the Nile.

Syn.—Cuneus (part), Megerle (not Da Costa, 1811). Sunetta, Link, 1807.

Distr.—11 sp. Senegal, India, Japan, Australia. Fossil: there are a few cretaceous and tertiary species. *M. picta*, Schum. (cxiii, 28).

Shell oval, compressed; anterior side rather longest; hinge with three cardinal teeth, and a long, narrow anterior tooth; lunule lanceolate; ligament in a deep escutcheon.

GRATELOUPIA, Desmoulins, 1828.

Distr.—Fossil, 4 sp. Eocene—Miocene; United States, France. *G. donaciformis*, Desm. (cxv, 41).

Shell subequilateral, rounded in front, attenuated behind; hinge with one anterior tooth, three cardinal teeth, and several small posterior teeth; pallial sinus deep, oblique.

CYTHERIOPSIS, Conrad, 1865. "Triangular; hinge composed of two compressed or linear teeth under the apex and two oblique anterior to them; in the left valve are four diverging teeth, the posterior one linear, and a lateral pyramidal compressed tooth anteriorly; cartilage-area rugose; pallial line with a shallow rounded sinus." *G. Hydana*, Conr. = *G. Moulinsii*, Lea (cxv, 29). Eocene; Alabama.

SUBFAMILY *DOSINIINÆ*.

Shell orbicular, mostly flattened and concentrically striate; pallial sinus oblique, triangular. Siphons united; foot subquadrangular, without byssiferous furrow.

DOSINIA, Scopoli, 1777.

Syn.—Artemis, Poli, 1791. Orbiculus, Muhlf., 1811. Exoleta, Brown. Asa, Leach.

Distr.—100 sp. Boreal—Tropical seas; low-water—80 fathoms. Fossil, 13 sp. Cret.—; United States, Europe, South India. *D. discus*, Reeve (cxiv, 32).

Shell orbicular, compressed, concentrically striated, pale, ligament sunk; lunule deep; hinge like Cytherea; margins even; pallial sinus deep, angular, ascending.

Animal with a large hatchet-shaped foot, projecting from the ventral margin of the shell; mantle-margins slightly plaited; siphons united to their ends; orifices simple, palpi narrow.

GEMMA, Deshayes.

Syn.—Tottenia, Perkins, 1869.

Distr.—U. S. *G. gemma*, Totten (cxiii, 29).

Shell rounded, subtriangular, subequilateral, smooth, margins crenulated within; hinge short and narrow; three teeth in the left valve, the middle one conical, arcuated; two divergent teeth and an intermediate pit in the right valve; pallial impression marginal, with a narrow deep sinus.

The species of this genus are very small, not exceeding 3·5 mill. in diameter.

CYPRIMERIA, Conrad, 1864.

Distr.—Cretaceous; North America, Europe. *C. discus*, Matheron (cxv, 39, 40, 42).

Shell lentiform; hinge of right valve broad, with a bifid oblique cardinal tooth and two oblique acute anterior teeth, with an intermediate pit for the reception of the tooth in the opposite valve.

CYCLINA, Deshayes.

Distr.—10 sp. Senegal, India, China, Japan, West America. Fossil, 1 sp. Miocene; Bordeaux. *C. Chinensis*, Chemn. (cxiv, 33).

Shell orbicular, somewhat convex, close; margins usually finely crenulated; beaks inclined anteriorly, no lunule; three small cardinal teeth, narrow, divergent and unequal; no lateral teeth; two large muscular impressions, anterior oval, posterior semilunar; pallial impression short, the sinus deep and angular; ligament long and narrow.

CLEMENTIA, Gray, 1840.

Distr.—6 sp. Australia, Philippines. *C. papyracea*, Gray (cxv, 43).

Thin, oval, white; ligament semi-internal; posterior teeth bifid, sinus deep and angular.

Animal with long, united siphons, and a large crescentic foot, similar to Dosinia.

THETIS, Sowerby, 1826.

Syn.—Thetironia, Stolicz., 1870.

Distr.—Cretaceous. *T. major*, Sowb. (cxv, 44). *T. hyalina*, Sowb. (cxiv, 34).

Shell thin, oval-subtrigonal, close, smooth, or concentrically striate; three unequal, parallel, narrow cardinal teeth in each valve, the posterior longest, lamelliform in the right, longer and thicker in the left valve; beaks rather large, inclined forwards; margins thin, simple; ligament narrow, inflated; muscular impressions submarginal; pallial impression slight, with a profound double sinuosity.

ÆORA, Conrad, 1870.

Distr.—*Æ. cretacea*, Conr. (cxxi, 4). Haddonfield, N. J.

Shell roundly ovate; right valve with three diverging cardinal teeth, posterior one bifid; cardinal plate broad, deeply channeled anteriorly, with a compressed, lateral tooth in the middle of the channel; plate deeply channeled posteriorly. Left valve with three diverging cardinal teeth, the anterior one Λ-shaped, oblique; one distant anterior lateral tooth with a channel above, parallel with the cardinal margin; nymphæ crenulated on the upper margin, a distant narrow channel on the posterior hinge-plate; pallial sinus deep, reaching to a point in a line with the posterior extremity of the posterior cardinal tooth; rounded and somewhat ascending.

Conrad says that this genus is nearly related to Isodoma, but it appears to be very like Cyclina and Thetis. The type species in general external characters of the shell also closely resembles some Cyprimeriæ.

SCALDIA, Ryckholt, 1852.

Distr.—2 sp. Carboniferous; Belgium. *S. Lambotheana*, Ryck. (cxv. 45).

Shell equivalve, roundly ovate, moderately tumid, with concentric striæ of growth; muscular scars two, anterior larger than posterior; pallial line with an angular, somewhat ascending sinus, as in Dosinia; hinge-line of the left valve with a single, tubercular, cardinal tooth below the umbo.

SUBFAMILY *TAPESINÆ.*

Shell oblong, transverse; cardinal teeth compressed; laterals, when present, simple. Siphons separate; foot lanceolate, byssiferous.

TAPES, Mühlfeldt.

Etym.—*Tapes*, tapestry.

Syn.—Omalia, Ryck., 1856. Parembola, Römer.

Distr.—78 sp. Norway, Britain, Black Sea, Senegal, Brazil, India, China, New Zealand; low-water—100 fathoms.—BEECHY. Fossil, 6 sp. Cretaceous—; Britain, France, Belgium, Italy. *T. litterata*, Linn. (cxiv, 35). *T. geographica*, Chemn. (cxiv, 36).

Shell oblong, umbones anterior, margins smooth; teeth three in each valve, more or less bifid; pallial sinus deep, rounded.

Animal spinning a byssus; foot thick, lanceolate, grooved: mantle plain or finely fringed; freely open in front; siphons moderate, separate half-way or throughout, orifices fringed, and cirri simple, branchial ramose; palpi long, triangular.

The animal is eaten on the southern European coasts; it buries in the sand at low-water, or hides in the crevices of rocks, and roots of sea-weed.

AMYGDALA, Römer. (Cuneus, Dacosta.) Radiately striate or decussate. *T. decussata*, Linn.

MYRSUS, H. and A. Ad., 1858. (Metis, Ad., 1857.) Concentrically wrinkled. *T. corrugata*, Desh.

PARATAPES, Stolicz., 1870. (Textrix, Römer, not Blachwall or Sundewal, 1833, = *Arachnoidea.*) Shell much elongated, compressed, outer surface smooth. *T. textrix*, Chemn.

HEMITAPES, Römer. Shell inflated, solid, ventricose, especially at the umbones, which are incurved, more or less narrower posteriorly; outer surface smooth. *T. pinguis*, Chemn.

PULLASTRA, Sowb. 1827.

Distr.—Eastern seas. *P. Malabarica*, Chemn. (cxiv, 37).

Shell transverse, oblong, oval and sometimes subtrigonal; hinge composed of three contiguous cardinal teeth, more or less divergent, sometimes bifid or simply channeled at the summit; beaks directed forward; margins simple; anterior muscular impression oval, posterior larger and rounded; pallial impression rather distant from the margin, with an oval, shallow sinus.

Animal with membranous, transparent mantle, the margins plain; siphons partly separate, unequal, the extremities with small tentacles, branchial siphon largest and longest; foot elongated, compressed, triangular, sometimes byssiferous; branchiæ unequal, united behind the foot and around the anal siphon; mouth oval, small.

LIOCYMA, Dall, 1870.

Distr.—2 sp. *L. fluctuosa*, Gould (cxxiii, 87).

Shell small, ovate, concentrically striated, compressed, nearly equivalve and rather thin; there are in each valve three cardinal teeth, the middle one cleft; pallial sinus small.

BARODA, Stoliczka, 1870.

Distr.—*B. fragilis*, d'Orb. (cxxi, 1–3). Cretaceous.

Shell very much elongated. very inequilateral, with subparallel upper and lower margins laterally compressed, pallial sinus moderate, horizontal or nearly so, obtuse at the end; hinge with three cardinal teeth in each valve, the posterior of which is very much elongated and sometimes longitudinally furrowed; the two other teeth sometimes appear as one widely bifid tooth; surface of valve smooth, only with concentric striæ of growth.

ICANOTIA, Stoliczka, 1869. Form similar to the last, inner edge of the shell anteriorly somewhat thickened, surface covered with radiating striæ and ribs, strongest on the posterior upper slope. *Psammobia impar*, Zittel.

FAMILY GLAUCOMYIDÆ.

Shell transverse, with a greenish epidermis. Siphons very long, compressed, united nearly to the extremity, which is fringed; foot large, linguiform, compressed, subcarinated.

GLAUCOMYA (Bronn), Gray.

Etym.—*Glaucos*, sea-green; *mya*, mussel.

Syn.—Glauconome, Gray, 1829 (not Goldfuss, 1826).

Distr.—16 sp. Embouchures of rivers; China, Philippines, Borneo, India. Fossil, 2 sp. Tertiary; Europe. *G. rugosa*, Reeve (cxii, 3–5).

Shell oblong, thin; epidermis dark, greenish; ligament external; hinge with three teeth in each valve, one of them bifid; pallial sinus very deep and angular.

Animal with a rather small, linguiform foot; pedal opening moderate; siphons very long, united, projecting far into the branchial cavity when retracted, their ends separate and diverging; palpi large, sickle-shaped; gills long, rounded in front, the outer shortest.

TANYSIPHON, Benson, 1855. Siphons united to the end; hinge with three teeth in the right and two in the left valve; pallial sinus very deep. Calcutta, buried in mud at extreme low-water. *G. rivalis*, Benson (cxii, 1, 2).

SUBORDER *INTEGRIPALLIATA.*

Siphons short, not retractile; the pallial impressions simple, usually without siphonal sinus.

(*Cyrenacea.*)

FAMILY CYRENIDÆ.

Shell suborbicular, closed, ligament external; epidermis thick, horny; umbones of aged shells eroded: hinge with two or three cardinals and lateral teeth; pallial line with a small inflection.

Animal with mantle open in front, margins plain; siphons (1 or 2) more or less united, orifices usually plain; gills two on each side, large, unequal, united posteriorly; palpi lanceolate; foot large, tongue-shaped.

Mr. Temple Prime, who has made a special study of this family, asserts that Oriental species of Cyrena and Corbicula differ from the American in not having a pallial sinus, but Dr. Stoliczka has observed it in Asiatic species, although not so well-developed as in those inhabiting America; it is present, but shallow, in fossil species of the Paris Basin.

CYRENA, Lam., 1806.

Etym.—*Cyrene*, a nymph.

Syn.—Pseudocyrena, Bourg., 1856. Cyanocyclas, Fer., 1818. Cyrenocyclas, Agass., 1847. Polymesoda, Raf., 1820. Leptosiphon and Cyrenocapsa, Fischer. Miodon, Dityporlon, Loxoptychodon and Donacopsis, Sandberger.

Distr.—100 sp. South America, Southern United States, East Indies, Polynesia. Fossil. Cretaceous—; North America, Europe. *C. Cyprinoides*, Quoy (cxiv, 38).

Shell rather thick, inflated or a little compressed, rounded or subtrigonal, subinequilateral, close, covered with a thick, greenish epidermis; three subequal, divergent, cardinal teeth in each valve; lateral teeth two, smooth or striated, the anterior rather thick, short, close, the posterior sublamellar, distant; beaks contiguous, eroded; ligament long and swollen; margins simple; muscular impressions small, oblong; pallial sinus inconspicuous.

Animal with the mantle open in front and below, margins plain; siphons short, orifices fringed; gills unequal, square in front, plaited, inner lamina free at base; palpi lanceolate; foot strong, tongue-shaped.

Cyrena inhabits the brackish waters of warm countries; they are usually found near the coast, often buried in the mud of mangrove-swamps. *C. Carolinensis*, Bosc, occurs plentifully in the rivers and swamps of So. Carolina, Georgia and Florida.

EGETA, H. and A. Adams, 1857. (Anomala, Desh.) Shell ventricose, thin, anteriorly short, posteriorly longer, subrostrated. *C. Floridana*, Conr. (cxv, 31).

DIODUS, Gabb, 1868. (Cyprinella, Gabb, olim.) Shell equivalve, subcordiform; hinge with three diverging (simple?) cardinal teeth, and one anterior and one posterior lateral smooth

tooth in each valve; pallial sinus shallow. Perhaps scarcely subgenerically distinct from Cyrena. For a doubtfully cretaceous species. *D. tenuis* (cxv, 32).

ISODOMA, Desh. Shell thin, fragile, resembling a Clementia, elongately ovate, moderately tumid; hinge of right valve with two bifid diverging cardinal teeth, and one distinct remote lateral tooth on either side; pallial sinus slight. Based on *I. cyrenoides*, Desh. (cxv, 33, 34); Paris Basin. It recalls Clementia in general character, but the dentition of the hinge is distinctly that of Cyrenidæ.

VELORITA, Gray, 1834.

Distr.—3 sp. Philippines, India, Japan. *V. Cyprinoides*, Gray (cxiv, 39, 40).

Shell with epidermis, cordiform, triangular, thick, solid; three cardinal teeth, the anterior one of the right valve and posterior of the left rather small; lateral teeth large, very finely striated, the anterior very large, triangular, the posterior compressed, elongated.

BATISSA, Gray, 1847.

Distr.—30 sp. Polynesia, Australia, E. Indies. *B. violacea*, Lam. (cxiv, 41–43).

Shell subcordiform, solid, covered with a horny, greenish epidermis; three cardinal teeth in each valve, the right anterior and left posterior ones rather small; lateral teeth compressed, striated, the anterior very short, posterior elongated.

CORBICULA, Muhlf., 1811.

Distr.—120 sp. India, East Indies, Philippines, So. America. *C. cor*, Lam. (cxiv, 44–46). Fossil. Laramie; N. America.

Shell subcordiform, solid, close, concentrically striated or ridged, covered by a smooth, greenish epidermis; three cardinal teeth in each valve, the right anterior and left posterior rather small; lateral teeth elongated, compressed, striated; ligament prominent, thick; pallial impression with a slight or well-marked sinus.

VELORITINA, Meek. Shell thick, gibbous, obliquely cordate-trigonal; beaks elevated, obliquely incurved, and tumid; posterior umbonal slopes very prominently rounded; posterior dorsal margins strongly incurved; cardinal teeth typical, excepting in being more oblique; lateral teeth with striæ very minute or obsolete, the posterior one of the left valve often appearing as if merely formed by the beveled edge of the incurved dorsal margin; ligament small and depressed far below the elevated umbonal slopes; surface concentrically striated. *Corbicula Durkeei*, Meek.

LEPTESTHES, Meek. Shell transversely elongate-subovate, compressed, typically extremely thin, very oblique; beaks depressed,

subanterior; hinge-plate rather wide; cardinal and lateral teeth typical, excepting that the cross-striæ are very obscure or obsolete and the posterior lateral rather short and very remote from the cardinal, with a wide, flattened space intervening; surface concentrically striated. *Corbicula fracta*, Meek.

SPHÆRIUM, Scopoli, 1777.

Syn.—Cyclas, Brug., 1792. Cornea, Muhlf., 1811. Corneocyclas, Fer., 1818.

Distr.—75 sp. Universal. Fossil. Laramie—; N. America Eocene—; Europe. *S. corneum*, Linn. (cxiv, 47).

Shell thin, oval or suborbicular, inflated, covered by a greenish epidermis; cardinal teeth very small or rudimentary, one more or less bifurcated, one in the right and two oblique ones in the left valve; lateral teeth compressed, lamelliform, the anterior shortest; ligament short; margins plain, muscular impressions scarcely apparent, submarginal; pallial impression simple.

Animal oval, subglobular; mantle-margins plain; siphons unequal, not ciliated, short, only united at the base, the branchial one largest and longest; mouth small, oval, transverse; branchial large, unequal, united behind, the inner ones largest; foot tongue-shaped, triangular, flattened, very extensible.

The fry of Sphærium are hatched in the *internal* branchiæ, they are few in number and very unequal in size; a full-grown *C. cornea* has about six in each gill; the largest being one-sixth to one-fourth the length of the parent. The young Sphæria and Pisidia are very active, climbing about submerged plants and often suspending themselves by byssal threads; the striated gills and pulsating heart are easily seen through the shell.

CYRENASTRUM, SPHÆRIASTRUM, Bourg.; CORNEOLA, CALYCULINA, Clessin, are names given to sections of the genus, possessing but slight differential characters.

PISIDIUM, Pfeiffer, 1821.

Syn.—Pera, Leach ? Musculium, Link, 1807. Pisum, Muhlf., 1811.

Distr.—60 sp. Universal. Fossil. Laramie; N. Am. Eocene—; Europe. *P. compressum*, Prime (cxiv, 48; cxv, 48).

Shell suboval, trigonal, inequilateral, covered by a greenish epidermis; cardinal teeth very small, elongated, one, sometimes bifurcated, in the right valve, two, diverging, in the left valve; lateral teeth longitudinal, compressed, lamelliform, double in the right valve.

Siphons short, simple, contractile, united to the end; foot linguiform, flattened, very extensible.

This is closely related to the preceding genus; but Pisidium has siphons united to the end, short; Sphærium, siphons elongated, separate. In Pisidium the cardinal teeth are elongated,

diverging; in Sphærium, tubercular or of columnar shape, placed obliquely toward each other.

EUPERA, Bourg., and FLUMINEA, RIVULINA and FOSSARINA, Clessin, are names of sections of the genus; they have but little distinctive value.

CYRENOIDES, Joannis, 1835.

Syn.—Cyrenella, Desh., 1833.

Distr.—4 sp. River Senegal. The marine species are Diplodontæ. Fossil, 1 sp. Europe. *C. Dupontii*, Joannis (cxiv, 49).

Shell orbicular, ventricose, thin, eroded at the beaks; epidermis dark olive; ligament external, prominent, elongated; cardinal teeth 3·2, the central tooth of the right valve bifid; muscular impressions long, narrow; pallial line simple.

Animal with mantle open in front and below, margin simple, siphons short, united; palpi moderate, narrow; gills very unequal, narrow, united behind; foot cylindrical, elongated.

? CYCLOCONCHA, Miller, 1874.

Distr.—*C. mediocardinalis*, Miller. L. Silur.; U. S.

Shell nearly circular, equivalve, concentrically sculptured, with a hinge-tooth and posterior and anterior laterals.

Its pertinence to this family is doubtful.

(*Cardiacea.*)

FAMILY CYPRINIDÆ.

Shell regular, equivalve, oval or elongated; valves close, solid; epidermis thick and dark; ligament external, conspicuous; cardinal teeth three in each valve, and a posterior lateral tooth; pedal scars close to, or confluent with. the adductors; pallial line slightly sinuous; siphons very short, with ciliated orifices; foot thick, linguiform.

CYPRINA, Lamarck, 1812.

Etym.—*Kuprinos* (from *Kupris*), related to Venus.

Syn.—Arctica, Schum., 1817.

Distr.—*C. Islandica* (cxiv, 50–52) ranges from Greenland and the United States to the Icy Sea, Norway and England; in 5–80 fathoms water. It occurs fossil in Sicily and Piedmont, but not alive in the Mediterranean. Fossil, 90 sp. (D'Orbigny.) Muschelkalk—; Europe, U. S.

Shell oval, large and strong, with usually an oblique line or angle on the posterior side of each valve; epidermis thick and dark; ligament prominent, umbones oblique; no lunule; cardinal teeth 2·2, laterals 0—1, 1—0; muscular impressions oval, polished; pallial sinus obsolete.

Animal with the mantle open in front and below, margins

plain; siphonal orifices close together, fringed, slightly projecting; outer gills semilunar, inner truncated in front.

The principal hinge-tooth in the right valve of Cyprina represents the second and third in Venus and Cytherea; the second tooth of the left valve is consequently obsolete.

CICATREA, Stoliczka, 1870. Shell with a sharp, high ridge; beaks distant and strongly incurved, with a short deeply bifurcate groove running posteriorly from each, in which is lodged the ligament; posterior cardinal teeth rather narrow in both valves (while in Cyprina proper the one in the right valve is very thick and bifurcate); the two anterior cardinals in the left valve are very large, the same superimposed teeth in the right valve, however, very small; the anterior muscular impression is anteriorly margined by a sharp ridge. The form of the shell strongly recalls Hemicardium. *Cyp. cordialis*, Stol. Cretaceous; India.

CYPRINOPSIS, Conrad, 1869, is characterized as equivalve, two anterior cardinal teeth and one very oblique tooth in the right valve, pallial line entire. *Artemis elliptica*, Smith. Does not appear to differ much from a typical Cyprina.

VELEDA, Conrad, 1870. Ovately elongated, tumid, posteriorly ridged from the umbo, concentrically striated on the surface, equivalved; left valve with a Λ-shaped cardinal tooth under the apex and three compressed teeth, posterior one elongated and parallel with the dorsal margin, cardinal plate channeled, deeply so anteriorly. *V. lintea*, Con. (cxv, 35). In this group also, the distinction from typical Cyprina appears to be unimportant.

GONIOSOMA, Conrad, 1869.

Distr.—*G. inflata*, Conr. Cret.; New Jersey.

Shell subquadrangular, moderately tumid, angular along the region from the beak to the infero-posterior end; muscular impressions marginal, pallial line—? hinge in the right valve with two prominent cardinal teeth and a long anterior lateral, parallel with the hinge-margin.

VENIELLA, Stoliczka, 1870.

Syn.—Venilia, Morton, 1834, not Duponchel, 1829, nor Alder and Hancock.

Distr.—Jurassic—Tertiary; U. S., Europe. *V. tumida*, Nyst. (cxv, 53).

Shell ventricose, inflated, umbonal slope posteriorly angulate, with the beaks outwardly incurved, more or less distant, a long narrow ligamental furrow running from them posteriorly, hinge with three cardinal and one posterior lateral tooth in each valve; right valve with the supra-posterior cardinal tooth, generally bifid anteriorly with a hook-like downward bent prolongation, infero-anterior cardinal smaller, lamelliform, or more or less tubercular, separated from the other tooth by a more or less

horizontally extending flexuous groove into which the infero-anterior cardinal tooth of the left valve fits, the supero-posterior cardinal of this valve is moderately prolonged, single or indistinctly bifid.

ANISOCARDIA, Munier-Chalmas, 1863. Surface radiately marked, umbonal ridge not angular. Cretaceous, Eocene. Type, *V. elegans*, Munier-Chalmas (cxv, 54–56), Kimmeridge clay, Havre.

VENILICARDIA, Stol., 1870. Shell, of large size, strong and thick, the supero-posterior cardinal teeth are usually more or less bifid, the one in the right valve with a very easy curve at the anterior end, the antero-inferior cardinal teeth of both valves are long, flexuous, and their posterior ends are in both cases strongly thickened and tubercular. Jurassic, Cretaceous, Tertiary. Type, *V. arcotica*, Stolicz. Cretaceous; India. *V. cordiformis*, d'Orb. (cxv, 57).

FAMILY ISOCARDIIDÆ.

Shell cordiform or transversely oblong, ventricose, sometimes carinated; beaks sometimes subspiral; two cardinal and two lateral teeth in each valve, the anterior lateral tooth occasionally obscure or rudimentary; muscular impressions narrow; pallial line simple.

ISOCARDIA, Lamarck, 1799.

Etym.—*Isos*, like, *cardia*, the heart. Heart-cockle.

Syn.—Glossus and Glossoderma, Poli, 1791. Bucardium, Muhlfeldt. Tychocardia, Römer.

Distr.—5 sp. Britain, Mediterranean, China, Japan. Fossil, 90 sp. Trias—; United States, Europe, South India. *I. cor*, Linn. (cxiv, 53–55).

Shell cordate, ventricose; umbones distant, subspiral; ligament external; hinge-teeth 2·2; laterals 1—1 in each valve, the anterior sometimes obsolete.

Animal with the mantle open in front; foot triangular, pointed, compressed; siphonal orifices close together, fringed; palpi long and narrow; gills very large, nearly equal.

The heart-cockle burrows in sand, by means of its foot, leaving only the siphonal openings exposed.—BULWER.

The Isocardia-shaped fossils of the old rocks belong to the genera Cardiomorpha and Isoarca; many of those in the Oolites to Ceromya. Casts of true Isocardia have only two transverse dental folds between the beaks, and no longitudinal furrows.

MIOCARDIA, H. and A. Adams, 1856. Shell without epidermis; beaks strongly curved, spiral; posterior umbonal slope carinated; surface concentrically ridged. *I. Moltkiana*, Chemn. (cxiv, 56).

CARDIODONTA, Stol., 1867. Shell cordiform, inflated, with prom-

inent incurved beaks, hinge with two cardinal and one thin or lamellar posterior lateral tooth in each valve; ligamental groove long, narrow, marginal; right valve with a strong, grooved posterior and one oblique simple anterior cardinal tooth, the latter running from the beak more or less parallel to the lunular margin; left valve with a single posterior and a thick anterior cardinal tooth strongly prominent above. *I. Balinensis*, Laube (cxv, 58–60).

CALLOCARDIA, A. Ad., 1864. Shell cordate and inflated like in Isocardia, posteriorly scarcely flexuous, thin and without epidermis; hinge of the left valve with two unequal cardinal teeth, the anterior angularly bent on itself in the middle with a triangular pit on either side and with four prominent cusps at the margin; the posterior oblique, curved, narrow, but elongated, and with two indistinct marginal cusps; no lateral teeth are present; pallial line simple and muscular impressions semilunar. There is as yet only one (left) valve of this remarkable species, *C. guttata*, known from the Chinese Seas. The absence of the posterior lateral tooth, as well as the peculiar cuspidation of the two hinge-teeth, distinguish it.

ISOCULIA, M'Coy, 1844. Under the name of *I. ventricosa*, M'Coy (cxv, 61) figures a very tumid, cordate shell with a few concentric distant constrictions, indicating stages of growth. The shell appears perfect and closed.

CYPRICARDIA, Lamarck, 1819.

Syn.—Trapezium, Muhlfeldt, 1811. Libitina, Schum., 1817.

Distr.—18 sp. Red Sea, India and Australia; in crevices of rock and coral. Fossil, 60 sp. Jurassic—; North America and Europe. *C. rostrata*, Lam. (cxvi, 68, 69).

Shell oblong, with an oblique posterior ridge; umbones anterior, depressed; ligament external, in deep and narrow grooves; cardinal teeth 2·2, laterals 1—1 in each valve, sometimes obscure; muscular impressions oval (of two elements); pallial line simple.

Animal (of *C. solenoïdes*) with mantle-lobes united, cirrated behind; pedal opening moderate; foot small, compressed, with a large byssal pore near the heel; siphons short, conical, unequal, cirrated externally; orifices fringed; palpi small; gills unequal, the outer narrower and shorter, deeply lamellated, united posteriorly, the inner prolonged between the palpi.

APRICARDIA, Gueranger, 1867. Shell elongated, inequilateral; hinge with one strong, recurved tooth in each valve, the tooth being in the left valve almost directly under the beak and in the right a little posterior to it; to each tooth corresponds an equally large cavity in the other valve. This peculiar form resembling

Cypricardia is distinguished by the simple form of its hinge; it is based upon a cretaceous species, *Cpr. carinata.*

GLOSSOCARDIA, Stolicz., 1870. Shell elongately trapezoid, subventricose, concentrically striated, beaks tumescent, obtuse, close together as in Cypricardia; ligamental furrow narrow and long as in Isocardia; hinge with two cardinal and one posterior lateral tooth in each valve; the supero-posterior cardinal teeth generally are more or less distinctly bifid, at least the one in the right valve, which has anteriorly a thin, subobsolete prolongation bent downward; it is separated from the inferior cardinal and bluntly tubercular tooth by a deep sickle-shaped groove, into which fits the similarly shaped antero-inferior cardinal tooth of the left valve; this tooth is provided on the upper side with two grooves, their distance being equal to the width of the pit into which the antero-inferior tooth of the right valve fits. *C. obesa*, Reeve (cxiv, 57). Mauritius.

MICRODON, Conrad, 1842. (Cypricardella, Hall. Eodon, Hall, 1877.) Shell ovate, subelliptical, or subquadrate; concentrically striated; hinge of right valve with two cardinal teeth; the anterior tooth beneath the beaks; posterior tooth turned obliquely backwards, leaving a triangular pit, which is probably occupied by a tooth in the other valve. Anterior cardinal margin with a long narrow groove, apparently for the reception of a slender projection of the other valve; posterior side beveled from above, edge thin; ligament external, in a deep cavity; muscular scars distinct, shallow; pallial line simple. Fossil. Carboniferous; Indiana. *M. subelliptica*, Hall.

? GONIOPHORA, Phillips, 1848. Silur., Devon.; Eur., N. Am. *C. cymbæformis*, Sowb. U. Silur.; England.

CORALLIOPHAGA, Blainv., 1824.

Syn.—Lithophagella, Gray, 1847.

Distr.—5 sp. Mediterranean, in the burrows of the Lithodomus; sometimes two or three dead shells are found one within the other, besides the original owner of the cell. South Sea. Fossil; Eocene—. *C. coralliophaga*, Gmel. (cxiv, 58, 59).

Shell long, cylindrical, thin, slightly gaping behind; hinge-teeth 2·2, and a laminar posterior tooth; pallial line with a wide and shallow sinus.

ANISODONTA, Deshayes, 1860.

Distr.—2 sp. I. Bourbon. *A. complanatum*, Dh. (cxv, 64). Eocene; Paris Basin.

Shell transversely elongated, compressed, inequilateral; hinge thick; a large conical tooth and a triangular socket in each valve; ligament external. Anterior adductor scar very small, and comprised between two prominent ribs (one parallel and the

other transverse to the anterior border); posterior scar subcircular, superficial; pallial line faint, entire.

CLOTHO, Faujas, 1808. Shell oval, subequilateral; two diverging cardinal teeth in each valve. *A. Faujasii* (cxv, 65). Tertiary; Europe.

CYPRICARDINIA, Hall, 1859.

Distr.—Silurian, Devonian; New York. *C. lamellosa*, Hall (cxxi, 32).

Shell elongately trapezoidal, moderately compressed, beaks anterior or subanterior, slightly prominent, surface concentrically lamellated or striated, with a posterior more or less distinct dorsal ridge; the ligament appears to have been thin; muscular impressions ovate, slightly impressed; hinge unknown.

This is a rather unsatisfactorily known palæozoic genus; the shells have the aspect of Cypricardia, but appear to be thinner, and nothing is known of their hinge by which their proper classification could be decided.

FAMILY CARDIIDÆ.

Shell regular, equivalve, free, cordate, ornamented with radiating ribs; posterior slope sculptured differently from the front and sides; cardinal teeth two, laterals 1·1 in each valve; ligament external, short and prominent; pallial line simple or slightly sinuated behind; muscular impressions subquadrate.

Animal with mantle open in front; siphons usually very short, cirrated externally; gills two on each side, thick, united posteriorly; palpi narrow and pointed; foot large, sickle-shaped.

CARDIUM, L., 1758.

Etym.—*Kardia*, the heart. Cockle.

Distr.—100 sp. World-wide; from seashore to 140 fathoms. Gregarious on sands and sandy mud. Fossil. 330 sp. Upper Silurian—.

Shell ventricose, close or gaping posteriorly; umbones prominent, subcentral; radiately ribbed; margins crenulated; pallial line more or less sinuated.

Animal with the mantle-margins plaited; siphons clothed with tentacular filaments, anal orifice with a tubular valve; branchial fringed; foot long, cylindrical, sickle-shaped, heeled.

The cockle (*C. edule*) frequents sandy bays, near low-water; a small variety lives in the brackish waters of the river Thames, as high as Gravesend, England; it ranges to the Baltic, and is found in the Black Sea and Caspian. *C. rusticum* extends from the Icy Sea to the Mediterranean, Black Sea, Caspian and Aral. On the coast of Devon (England) the large prickly cockle (*C. aculeatum*) is eaten.

CARDIUM, restricted. (Tropidocardium, Römer.) Shell ventricose, subeqilateral, more or less gaping behind; margin strongly dentate; valves covered with strong radiating ribs. *C. costatum*, Linn. (cxvi, 70).

BUCARDIUM, Gray. (Pectunculus, Adanson.) Shell globose, solid, strongly ribbed, the ribs produced on the gaping posterior margin into strong spine-like teeth. *C. ringens*, Chemn. (cxvi, 71).

TRACHYCARDIUM, Mörch. (Granocardium, Gabb. Criocardium, Conrad, 1870.) Shell oblong, inflated, a little oblique, radiately ribbed; the tops or sides of the ribs scaly spinose. *C. muricatum*, L. (cxvi, 72–74). West Indies. Fossil. Cret.; California. Criocardium is "Multiradiate, interstices spinose, ribs smooth; anterior lateral tooth long and prominent." *C. dumosum*, Conr. Cret.; N. Jersey. The spines originate laterally on the ribs (as is not unusual in the genus), and not between them.

ACANTHOCARDIA, Gray, 1847. (Isocardia, Klein.) Shell subglobose, radiately ribbed, the ribs bearing strong, sharp, curved spines. *C. aculeatum*, Linn. (cxvi, 75).

CERASTODERMA, Poli, 1791. Shell subcordiform, rounded behind; valves close, flatly ribbed; cardinal teeth strong. *C. edule*, Linn. (cxvi, 76).

PAPYRIDEA, Swains., 1840. Shell oval, oblong or transverse, thin, inequilateral; radiately ribbed, the ribs forming strong marginal teeth posteriorly. *C. hiulca*, Reeve (cxvi, 77).

FULVIA, Gray, 1847. Shell transversely oblong, very inequilateral, posteriorly produced, radiately ribbed. Differs very little from the last group. *C. bullata*, Linn. (cxvi, 78).

LYMNOCARDIUM, Stol., 1870. (Pseudocardia [part], Conrad, 1866. Vetocardia [part], Conrad, 1868.) Shell elongated, inequivalve, with the anterior side shorter, moderately inflated and rather thin, surface radiately ribbed; cardinal teeth two, or one in each valve, small, and sometimes quite obsolete, lateral teeth remote, more or less lamelliform, pallial line either entire or (rarely) sinuated, posterior gape usually distinct. Type, *Cardium Haveri*, Hörnes. The species are Tertiary; Eastern Europe, W. Asia. The type is one of the species which Conrad quotes under his genus Pseudocardia, the name of which the same author subsequently replaces by Vetocardia. When giving the characteristics of the latter, he evidently refers solely to d'Orbigny's cretaceous Venericardiæ, but how it was possible to associate with these forms the first named ones and others described by Hörnes from the uppermost tertiary beds of the Vienna (or rather Hungarian) Basin, it is really difficult to understand, and this the more when, after the enumeration of

the species, we find the following statement: "a genus which became extinct in the upper cretaceous period."

APHRODITA, Lea, 1834.

Syn.—Acardo, Swains. [pt.], 1840. Serripes, Beck, 1844.

Distr.—*A. Grœnlandica*, Chemn. (cxvi, 79–81). Arctic seas.

Shell subcordiform, compressed, subequilateral; surface smooth or slightly radiately striate; beaks prominent; cardinal and lateral teeth obtuse, small, almost obsolete.

LÆVICARDIUM, Swainson, 1840.

Syn.—Liocardium, Mörch, 1852.

Distr.—21 sp. Universal. *L. serratum*, Linn. (cxvi, 83).

Shell oval, elongated, oblique, somewhat inequilateral; surface smooth or lightly radiately striate.

PROTOCARDIUM, Beyrich, 1845. Posterior half of shell radiately striate, anteriorly half distantly concentrically striate. *L. lyratum*, Sowb. (cxvi, 82). There are several recent forms. *L. Hillanum*, Sowb., is a cretaceous example.

NEMOCARDIUM, Meek, 1876. Shell closely resembling the typical forms of Protocardia, but thinner, with two-thirds to three-fourths of surface in front of the stronger posterior, usually echinate, radiating costæ, occupied by fine, crowded, radiating striæ, and the free margins crenate within all around; cardinal and lateral teeth generally rather slender; pallial line faintly sinuous, irregularly serrated, or nearly simple behind. *L. semiasperum*, Desh.

PACHYCARDIUM, Conr., 1870. Shell very massive, much higher than long; valves very gibbous; hinge remarkably strong; surface sculpturing rather obscure, the posterior radiating costæ being nearly obsolete. *L. Spillmani*, Conr.

LEPTOCARDIA, Meek, 1876. Shell small, very thin, as high or higher than long; hinge weak; surface nearly smooth, the posterior radiating costæ being obsolete, or often only indicated by crenulations along the posterior third of the free margins within; pallial line with two shallow sinuses. *L. subquadratum*, Evans and Shumard.

ADACNA, Eichwald, 1838.

Syn.—Acardo, Swains. [pt.], not Brug. Hypanis, Pander.

Distr.—8 sp. Aral, Caspian, Azof, Black Sea, and the embouchures of the Wolga, Dniester, Dnieper, and Don; burrowing in mud. *A.* [illegible], Pallas (cxvi, 84).

Shell compressed, gaping behind, thin, nearly edentulous; pallial line sinuated.

Animal with the foot compressed; siphons elongated, united nearly to the end [illegible]. The siphonal inflection varies in amount

The transitions between the type and the following subgenera are so gradual that the latter must be regarded as of little value.

MONODACNA, Eichw., 1838. Hinge with a single tooth. *A. Caspicum*, Eichw. (cxvi, 85).

DIDACNA, Eichw., 1838. Hinge with two teeth. *A. Donaciformis*, Schröter (cxvi, 85).

PROSODACNA, Tournouer, 1882. *A. macrodon*, Desh. Tertiary; Crimea.

HEMICARDIUM, Cuvier, 1817.

Distr.—28 sp. Tropical. *H. cardissa*, Linn. (cxvi, 87). *H. hemicardium*, Linn. (cxvi, 88).

Shell cordiform, the posterior slope strongly depressed and bordered by a carina; lunule simple; cardinal teeth distinct, more or less twisted; surface radiately ribbed.

FRAGUM, Bolten, 1798. Anterior side short and truncated; ribs tuberculated. *H. unedo*, Linn. (cxvi, 89).

CTENOCARDIA, H. and A. Adams, 1855. Like Fragum, but ribs spinose. *H. hystrix*, Brod. (cxvi, 90, 91).

LUNULICARDIA, Gray, 1847. Lunule depressed, surrounded by a deep broad channel; ribs nearly smooth and flattened on the posterior slope. *H. retusa*, Linn. (cxvi, 92).

CONOCARDIUM, Bronn.

Syn.—Lychas, Stein. Pleurorhynchus, Ph. Lunulocardium, Münster. Arcites, Martin.

Distr.—Fossil, 30 sp. U. Silurian — Carb.; North America, Europe. *C. aliforme*, Sowb. (cxvi, 93). *C. Hibernicum*, Sowb. (cxvii, 100).

Shell equivalve-trigonal, conical and gaping in front, truncated behind, with a long siphonal tube near the umbones; anterior slope radiately, posterior obliquely striated; margins strongly crenulated within; hinge with anterior and posterior laminar teeth; ligament external.

The truncated end has usually been considered *anterior*, a conclusion which seems incompatible with the vertical position and burrowing habits of most free and equivalve shells; if compared with Adacna the large gape will be for the foot, and the long tube siphonal. *C. Hibernicum* has an expanded keel, like *Hemicardium inversum*. The shell-structure is prismatic-cellular, as first pointed out by Sowerby; but the cells are cubical, and much larger than in any of the Aviculadæ. In Cardium, the outer layer is only corrugated or obscurely prismatic-cellular.

LITHOCARDIUM, Desh. Shell triangular, keeled; anterior side very short; hinge-teeth 1·2, directed backwards; posterior laterals 2·1; anterior muscular pit minute, posterior impression large, remote from the hinge. *L. cymbulare*, Lam., exhibits slight indications of a byssal sinus in the front margins of the

valves. Fossil. Eocene; France. *L. aviculare*, Lam. (cxvii, 1). These shells present considerable resemblance to Tridacna.

GOLDFUSSIA, Castelnau, 1843, is based upon *Cardium nautiloides*, each valve of which is said to resemble a laterally compressed nautilus, keeled on either side. Silurian; South America.

? DEXIOBIA, Winchell, 1863.

Distr.—Devon., Carb.; U. S. *D. ovata*, Hall.

Shell thin, inequivalve, inequilateral; beaks separated by an undefined area; right valve very ventricose, with a very prominent umbo, and a produced, incurved beak strongly inclined forward; left valve much less inflated, with a less prominent beak, scarcely elevated above the dorsal margin; hinge-line more or less extended, straight or slightly bent, edentulous? furnished with a thickened cartilage-plate bearing a lineal posterior groove; pallial line and muscular markings unknown.

CARDIOPSIS, Meek and Worthen, 1861.

Distr.—Several palæozoic species; U. S. *C. radiata*, M. and W. (cxvi, 95).

Shell equivalve, somewhat inequilateral, very slightly oblique, ovate or cordiform, entirely closed; beaks rather elevated, distinctly incurved, and directed towards the anterior side; surface marked by radiating striæ or costæ; cardinal margin short, and rounding into the posterior border; hinge provided with one or two distinct anterior teeth in each valve, near the beaks (ligament and muscular impressions unknown).

BYSSOCARDIUM, Munier-Chalmas, 1882.

Distr.—2 sp. Eocene and Miocene; France. *B. emarginatum*, Desh.

Shell allied to Lithocardium, but characterized by an anterior opening for a large byssus, having margins toothed like those of a Tridacna; anterior muscular impression very feeble, placed below the posterior cardinal tooth.

FAMILY VERTICORDIIDÆ.

Shell equivalve, or nearly so, of small size, inflated, with the beaks incurved, closed all round, more or less solid, pearly inside; hinge with few cardinal teeth, more or less obsolete, ligament subinternal or internal; two muscular impressions, pallial line simple.

The animal of *V. Japonica* has the mantle-margins united, with a small anterior opening for the protrusion of the foot, which is small, triangular, compressed, and a posterior roundish, fringed opening in which are inclosed two separated but very short siphons; labial palps small.

The curious history of the genera of this family, and of the many conflicting views of their extent and relationships, is ably given by Prof. Angelo Heilprin in Proc. Acad. Nat. Sciences, Philad., 423, 1881.

VERTICORDIA, Searles Wood, 1844.

Etym.—*Verticordia*, a name of Venus.

Syn.—Trigonulina, d'Orb.

Distr.—3 sp. China Sea, Mediterranean ? Fossil, 2 sp. Miocene—; Britain, Sicily, North Carolina. *V. cardiiformis*, Wood (cxxv, 26).

Shell suborbicular, with radiating ribs; beaks subspiral; margins denticulated; interior brilliantly pearly; hinge with one prominent cardinal tooth in each valve; adductor scars two, faint; pallial line simple; ligament internal, oblique; epidermis dark brown.

PECCHIOLA, Meneghini, 1851.

Distr.—3 sp. N. Europe. *P. argentea*, Meneg. Miocene; Europe.

Shell suborbicular, equivalve, strongly ventricose, with the beaks incurved and distant from each other, surface radiately sulcated and ribbed; hinge in the right valve with a strong cardinal tooth below the umbo, a corresponding indentation in the left valve; ligament apparently linear, situated along the upper posterior margin.

ALLOPAGUS, Stoliczka, 1870.

Syn.—Hippagus, Deshayes, non Lea.

Distr.—*Hippagus Leanus*, Deshayes (cxxvii, 60 . Paris Basin.

Shell ovate, thin, very inequilateral, moderately tumid, with small approximate beaks; surface smooth with simple striæ of increase; right valve with one tooth in front of the umbo, left with a similar tooth below the umbo; ligament subinternal, posterior.

The type of this group is *Hippagus Leanus*, Deshayes. The species differs by the hinge and the structure of its shell from Hippagus, Lea's original figure of *H. isocardoides* being apparently quite correct—the latter group belonging to all appearances close to Mysia in the Ungulinidæ. Deshayes' species is externally very like a Mytilimeria, but this again accords in the character of its hinge with true Hippagus.

(*Chamacea.*)

FAMILY CHAMIDÆ.

Shell inequivalve, thick, attached; beaks subspiral; ligament external; hinge-teeth two in one valve, one in the other; adductor impressions large, reticulated; pallial line simple.

Animal with the mantle closed; pedal and siphonal orifices small, subequal; foot very small; gills two on each side, very unequal, united posteriorly.

CHAMA (Pliny), Linn.

Distr.—50 sp. Tropical seas, especially amongst coral reefs; fifty fathoms. West Indies, Canaries, Mediterranean, India, China. Fossil, 40 sp. Cret.—; United States, Europe. *C. lazarus*, Linn. (cxvi, 98).

Shell attached usually by the left umbo; valves foliaceous, the upper smallest; hinge-tooth of free valve thick, curved, received between two teeth, in the other; adductor impressions large, oblong, the anterior encroaching on the hinge-tooth.

Animal (cxvii, 3, 4) with the mantle-margins united by a curtain, with two rows of tentacular filaments; siphonal orifices wide apart, branchial slightly prominent, fringed, anal with a simple valve; foot bent, or heeled; liver occupying the umbo of the attached valve only; ovary extending into both mantle-lobes, as far as the pallial line; lips simple, palpi small and curled; gills deeply plaited, the outer pair much shorter and very narrow, furnished with a free dorsal border, and united behind to each other, and to the mantle; adductors each composed of two elements.

The shell of Chama consists of three layers; the external, colored layer is laminated by oblique lines of growth, with corrugations at right-angles to the laminæ; the foliaceous spines contain reticulated tubuli; the middle layer is opaque white, and consists of ill-defined vertical prisms or corrugated structure; the inner layer, which is translucent and membranous, is penetrated by scattered vertical tubuli; the minute processes that occupy the tubuli give to the mantle (and to the casts of the shell) a granular appearance.

Some Chamas are attached indifferently by either valve; when fixed by the right valve the dentition is reversed, the left valve having the single tooth.

ARCINELLA, Schumacher, 1817. Shell nearly regular and equivalve, ribbed and spiny, with a distinct lunule, attached by the right valve. *C. arcinella*, Linn. (cxvi, 99). The subgenus is scarcely warranted by its distinctive characters. Like most attached shells, the Chamæ are very irregular in form and sculpture; the same species may be simply ribbed, or foliated, or spinose, according to circumstances. The consequence of this variability has been an undue multiplication of species.

MONOPLEURA, Matheron, 1842.

Distr.—Fossil, 10 sp. Neocomian—Chalk; France, Texas. *M. Urgonensis*, Matheron (cxvii, 2).

Shell attached by the dextral umbo; valves alike in structure and sculpturing; fixed valve straight, inversely conical, with a long, straight ligamental groove, and obscure hinge-area; opercular valve flat or convex, with an oblique, submarginal umbo.

They are commonly found in groups, adhering laterally, or rising one above the other; the casts of such as are known are quite simple and Chama-like.

VALLETIA, Munier-Chalmas, 1872. *V. Tombecki*, M.-Ch. Neocomian; Savoy.

DICERAS, Lamarck, 1804.

Syn.—Heterodiceras, Munier-Chalmas. Pseudodiceras, Gemmellaro.

Distr.—5 sp. Middle Oolite; Germany, Switzerland, France, Algeria. *D. arietinum*, Lam. (cxvii, 5–7).

Shell subequivalve, attached by either umbo; beaks very prominent, spiral, furrowed externally by ligamental grooves; hinge very thick, teeth 2·1, prominent; muscular impressions bounded by long spiral ridges, sometimes obsolete.

Diceras differs from Chama in the great prominence of both its umbones, in having constantly two hinge-teeth in the right valve and one in the left, and in the prominent ridges bordering the muscular impressions. Similar ridges exist in Cucullæa, Megalodon, Cardilia, and Hippurites; they produce deep spiral furrows on the casts, which are of common occurrence in the Coral-oolite of the Alps. One or both the anterior furrows are frequently obsolete. The dental pits are much deeper than the teeth which they receive, and are subspiral, giving rise to bifid projections on the casts; the single tooth in the left valve consists of two elements, and the cavity (fosset) which receives it is divided at the bottom.

Munier-Chalmas divides Diceras thus:

DICERAS, Lam., 1805. Posterior muscular impression on a plate, more or less elevated, the anterior upon plate-like ridges. *D. arietinum*, Lam.

HETERODICERAS, Munier-Chalmas, 1869. Posterior impression in each valve upon horizontal or concave surfaces, connected to the cardinal plate, anterior impression upon similar surfaces, more or less horizontal. *D. Lucii*, Defrance.

PLESIODICERAS, Munier-Chalmas, 1882. Postero-cardinal tooth more or less prolonged anteriorly, and reversed behind; posterior muscle advancing a little between the cardinal margin and the base of the postero-cardinal tooth. *D. Valfinense*, Boehm.

BAYLEIA, Munier-Chalmas, 1872. One valve resembling Diceras by its raised plate for the muscular impression, the other approaching caprinoid groups by its beak and by the two cavities

for the insertion of the anterior muscle. *D. Pouechi*, Munier-Chalmas. Cret.; France.

REQUIENIA, Matheron, 1842.

Dedicated to M. Requien, author of a Catalogue of Corsican Mollusca.

Distr.—Fossil, 7 sp. Neocomian—L. Chalk; Britain, France, Spain, Algeria, Texas. *R. Lonsdalii*, Sowb. (cxvii, 8, 9, 12). *R. ammonia*, (cxvii, 10, 11).

Shell thick, very inequivalve, attached by the left umbo; ligament external; teeth 2·1; left valve spiral, its cavity deep, not concamerated; free valve smaller, subspiral; posterior adductor bordered by a prominent subspiral ridge in each valve.

The shell-structure of Requienia is like Chama. The relative size of the valves is subject to much variation; in *R. Favri* (Sharpe) they are nearly equal. The hinge-teeth are like those of Diceras; the cavity for the posterior tooth of the right valve is very deep and subspiral. The internal muscular ridges are produced by duplicatures of the shell-wall, and are indicated outside by grooves. In *R. subæqualis* and *Toucasiana* there is a second parallel ridge, as in Hippurites and Caprotina.

The following uncharacterized groups are probably not very distinct from Requienia.

TOUCASIA, Munier-Chalmas, 1873. *T. carinata*, Matheron. Urgonian.

MATHERONIA, Munier-Chalmas, 1873. *M. Virginiæ*, Sc. Urgonian.

ETHRA, Matheron. *E. Munieri*, Math. Urgonian.

CAPRINA, C. d'Orbigny, 1823.

Etym.—*Caprina*, pertaining to a goat.

Syn.—Sphærucaprina, Gemm. Plagioptychus, Matheron, 1842. Gemmellaria, Munier-Chalmas.

Distr.—Fossil, 10 sp. Upper Greensand and Lower Chalk; Bohemia, France, Texas.

Shell with dissimilar valves, with subspiral beaks; fixed valve conical, marked only by lines of growth and a ligamental groove; hinge-margin with several deep cartilage-pits; and one large and prominent tooth on the posterior side; free valve oblique or spiral, thick, perforated by one or more rows of flattened canals, radiating from the umbo and opening around the inner margin; anterior tooth supported by a plate which divides the umbonal cavity lengthwise, posterior tooth obscure; hinge-margin much thickened, grooved for the cartilage.

In *C. adversa* (cxvii, 13; cxviii, 19) the free valve is sinistrally spiral; its cavity is partitioned off by numerous septa, and divided longitudinally by the dental plate. When young it is attached by the apex of the straight valve, but afterwards

becomes detached, as the large specimens are found imbedded with the spire downwards.—SAEMANN.

LYCODUS, Schafhaeutl, 1863. Shell inequivalve, oblong, moderately tumid, with large incurved and rather approaching beaks; of solid structure and concentrically costate. In the place of the hinge there seems to be in the left valve a large hinge-plate, the anterior portion of which is partially elevated and prolonged into a transverse tooth, and the posterior depressed, probably for the reception of the tooth of the other valve. From the posterior part a rib runs internally up to the umbones, and there is also a posterior elongated tooth present almost parallel to the margin of the shell. One species, *L. cor*, is figured and described from an Alpine limestone bed, probably lower secondary.

CAPROTINA, d'Orbigny, 1842.

Distr.—Fossil, 10 sp. Upper Greensand; France. *C. striata*, d'Orb. (cxvii, 14, 15). *C. quadripartita* (cxviii, 21).

Shell composed of two distinct layers; valves alike in structure, dissimilar in sculpturing; ligamental groove slight; cartilage internal; right valve fixed, striated or ribbed, with one narrow tooth between two deep pits, several pits on each side of the ligamental inflection, posterior adductor supported by a plate; free valve flat or convex, with a marginal umbo; teeth two, very prominent, supported by ridges (apophyses) of the adductor muscles, the anterior tooth connected with a third plate which divides the umbonal cavity.

The smaller Caprotinæ occur in groups, attached to oyster-shells; their muscular ridges are much less developed than in the large species. *C. costata* is like a little Radiolite.

CAPRINELLA, d'Orbigny, 1847.

Syn.—Caprinula (*Boissii*), d'Orbigny, 1847. Ichthyosarcolithes, Desm. ? Chaperia, Mun.-Chal., 1873.

Distr.—Fossil, 6 sp. Cretaceous; France, Portugal, Sicily. *C. Aiguilloni* (cxviii, 18).

Shell fixed by the apex of the right valve, or free; composed of a thick layer of open tubes, with a thin compact superficial lamina; cartilage internal, contained in several deep pits; umbones more or less camerated; right valve conical or elongated, with a ligamental furrow on its convex side, and furnished with one strong hinge-tooth supported by an oblique plate; left valve oblique or spiral, with two hinge-teeth, the anterior supported by a plate which divides the umbonal cavity lengthwise.

In *C. triangularis*, Desm. (cxviii, 22, 23), the umbonal cavity of the spiral valve is partitioned off at regular intervals; the length of the water-chambers is sometimes $3\frac{1}{2}$ inches, and of

the body-chamber from 2 to 7 diameters; specimens measuring a yard across may be seen on the cavernous shores of the islets near Rochelle.—PRATT.

CHAMOSTREA, Roissy, 1805.

Syn.—Cleidothærus, Stutch., 1829.

Distr.—1 sp. New South Wales. *C. albida*, Lam. (cxvii, 16, 17).

Shell inequivalve, Chama-shaped, solid, attached by the anterior side of the deep and strongly-keeled dextral valve; umbones anterior, subspiral; left valve flat, with a conical tooth in front of the cartilage; cartilage internal, with an oblong, curved ossicle; muscular impressions large and rugose, the anterior very long and narrow; pallial line simple.

Animal with mantle-lobes united by their extreme edge between the pedal orifice and siphons; pedal opening small, with a minute ventral orifice behind it; siphons a little apart, very short, denticulated; body oval, terminating in a small, compressed foot; lips bilobed, palpi disunited, rather long and obtusely pointed; gills one on each side, large, oval, deeply plaited, prolonged in front between the palpi, united posteriorly; each gill traversed by an oblique furrow, the dorsal portion consisting of a single lamina with a free margin.

FAMILY HIPPURITIDÆ.

(Order Rudistes, Lamarck.)

Shell inequivalve, unsymmetrical, thick, attached by the right umbo; umbones frequently camerated; structure and sculpturing of valves dissimilar; hinge-teeth 1·2; adductor impressions two, large, those of the left valve on prominent apophyses.

The shells of this extinct family are characteristic of cretaceous strata, and abound in many parts of the Peninsula, the Alps, and Eastern Europe, where the equivalent of the Lower Chalk has received the name of "Hippurite limestone." They occur also in Turkey and in Egypt, and Dr. F. Römer has round them in Texas and Guadaloupe. The structure of these shells has been fully described in the Quarterly Journal of the Geological Society of London. In all the genera the shell consists of three layers, but the outermost, which is thin and compact, is often destroyed by the weathering of the specimens. The principal layer in the lower valve of Hippurites is not really very different from the upper valve in structure; the laminæ are corrugated, leaving irregular pores, or tubes, parallel with the long axis of the shell, and often visible on the rim. The umbo of the upper valve of Radiolites is marginal in the young shell.

They are the most problematic of all fossils; there are no recent shells which can be supposed to belong to the same family; and the condition in which they usually occur has involved them in greater obscurity. The characters which determine their position amongst the ordinary bivalves are the following:—

1. The shell is composed of three distinct layers.
2. They are essentially unsymmetrical, and right-and-left valved.
3. The sculpturing of the valves is dissimilar.
4. There is evidence of a large internal ligament.
5. The hinge-teeth are developed from the free valve.
6. The muscular impressions are two only.

The outer layer of shell in Radiolites consists of prismatic cellular structure; the prisms are perpendicular to the shell-laminæ, and often minutely subdivided. The cells appear to have been empty, like those of Ostrea. The inner layer, which forms the hinge and lines the umbones, is subnacreous, and very rarely preserved. It is usually replaced by calcareous spar, sometimes by mud or chalk, and very often it is only indicated by a vacuity between the outer shell and the internal mould. The inner shell-layer is seldom compact, its lamellæ are extremely thin, and separated by intervals like the water-chambers of Spondylus; similar spaces occur in the deposit, filling the umbonal cavity of the long-beaked oysters.

The chief peculiarity of the Hippuritidæ is the dissimilarity in the structure of the valves, but even this is deprived of much significance by its inconstancy. The free valve of Hippurites is perforated by radiating canals which open round its inner margin, and communicate with the upper surface by numerous pores, as if to supply the interior with filtered water; possibly they were closed by the epidermis. In the closely allied genus Radiolites there is no trace of such canals.

The teeth of the left, or upper, valve are so prominent and straight, that its movement must have been nearly vertical, for which purpose the internal ligament appears to have been exactly suited by its position and magnitude; but it is probable that, like other bivalves, they opened to a very small extent.

Hippurites, Lamarck, 1801.

Etym.—Adopted from old writers, "fossil Hippuris," or Horse-tail. *Syn.*—Batolites, Raphanistes, Montf.

Distr.—Fossil, 30 sp. Chalk; Bohemia, Tyrol, France, Spain, Turkey, Syria, Algeria, Egypt. *H. toucasianus* (cxviii, 27, 28). *H. sulcatus*, Defrance (cxviii, 29, 30).

Shell very inequivalve, inversely conical, or elongated and cylindrical; fixed valve striated or smooth, with three parallel

furrows on the cardinal side, indicating duplicatures of the outer shell-layer; internal margin slightly plaited; umbonal cavity moderately deep, ligamental inflection with a small cartilage-pit on each side; dental sockets subcentral, divided by an obsolete tooth; anterior muscular impression elongated, double, posterior small, very deep, bounded by the second duplicature; third duplicature projecting into the umbonal cavity; free valve depressed, with a central umbo, and two grooves or pits corresponding to the posterior ridges in the lower valve; surface porous, the pores leading to canals in the outer shell-layer, which open round the pallial line upon the inner margin; anterior cartilage-pit deep and conical, posterior shallow; umbonal cavity turned to the front; teeth two, straight, subcentral, the anterior largest, each supporting a crooked muscular apophysis, the first broad, the hinder prominent, tooth-like; inflections surrounded by deep channels.

H. cornu-vaccinum (cxvii, 18, 19; cxviii, 24) attains a length of more than a foot, and is curved like a cow's horn; the outer layer separates readily from the core, which is furrowed longitudinally. The ligamental inflection is very deep and narrow, and the anterior tooth farther removed from the side than in *H. bioculatus* and *radiosus* (cxviii, 25, 26); the posterior apophysis does not nearly fill the corresponding cavity in the lower valve. In *H. bioculatus* and some other species there is no ligamental ridge inside; these, when they have lost their inner layer, present a cylindrical cavity, with parallel ridges extending down one side. The third inflection is possibly a siphonal fold, such as exists in the tube of Teredo, and sometimes in the valves of Pholas, Clavagella, and the caudate species of Trigonia.

The development of processes from the upper valve, for the attachment of the adductor muscles, harmonizes with the other peculiarities of Hippurites. The equal growth of the margins of the valves produces central umbones, and necessitates an internal cartilage; this again causes the removal of the teeth and adductors farther from the hinge-margin, to a position in which the muscles must have been unusually long, unless supported in the manner described. Supposing the animal to have had a small foot, like Chama, the mantle-opening for that organ would have been completely obstructed by the adductor, but that the muscular support was hook-shaped. The posterior adductor-process is similarly under-cut for the passage of the rectum, which in all bivalves emerges between the hinge and posterior adductor, winds round outside that muscle, and terminates in the line of the exhalent current. There is a groove (sometimes an inch deep) round the second and third duplicatures in the upper valve, which seems intended to facilitate the passage of the alimentary canal, and the flow of water from the

gills into the exhalent channel. The smallness of the space for the branchiæ may have been compensated by deep plication of those organs, as in Chama and Tridacna.

HIPPURITES (restricted). Hinge-rib well-developed. *H. cornu-vaccinum*, Bronn.

D'ORBIGNYA, Woodward, 1862. "No ligamental inflection of the outer shell." Doubtfully distinct. Fossil, 4 sp. Middle Chalk; Europe. *H. bioculatus*, Lam.

BARRETTIA, Woodward, 1862. Dedicated to Mr. Lucas Barrett, late Director of the Geological Survey of the West Indies. No "ligamental inflection" as in d'Orbignya, but it presents the further peculiarity of an indefinite number of pallial duplicatures extending all round the margin of the lower valve. Type, *B. monilifera*, Woodward. "Hupperite limestone." Jamaica. This is a doubtful group; its pertinence to the genus, and even to mollusca, has been questioned.

PIRONÆA, Meneghini, 1868. Shell strongly ribbed; the hinge-lamina short and thick. *H. organisans*, Mont.

RADIOLITES, Lamarck, 1801.

Etym.—Radius, a ray.

Distr.—Fossil, 42 sp. Neocomian—Chalk; Texas, Britain, France, Bohemia, Saxony, Portugal, Algeria, Egypt. *R. alata*, d'Orb. (cxviii, 31). *R. mamillaris*, Math. (cxviii, 32–35). *R. Hæninghausii* (cxviii, 36, 37).

Shell inversely conical, biconic, or cylindrical; valves dissimilar in structure; internal margins smooth or finely striated, simple, continuous; ligamental inflection very narrow, dividing the deep and rugose cartilage-pits; lower valve with a thick outer layer, often foliaceous; its cavity deep and straight, with two dental sockets and lateral muscular impressions; upper valve flat or conical, with a central umbo; outer layer thin, radiated; umbonal cavity inclined towards the ligament; teeth angular, striated, supporting curved and subequal muscular processes.

The upper valve of *R. fleuriausus* has an oblique umbo, with a distinct ligamental groove. The foliations of the lower valve are frequently undulated; they are sometimes as thin as paper, and several inches wide.

The umbonal cavity of the lower valve is partitioned off by very delicate funnel-shaped laminæ. Specimens frequently occur in which the outer shell-layer is preserved, whilst the inner is wanting, and the mould ("birostrites") remains loose in the centre. The interior of the outer shell-layer is deeply grooved with lines of growth, and exhibits a distinct ligamental ridge in each valve.

In aged examples of *R. calceoloides* the ligamental inflection is concealed, the cartilage-pits partially filled up and smoothed,

and the teeth and apophyses so firmly wedged into their respective cavities as to suggest the notion that the valves had become fixed about a quarter of an inch apart, and ceased to open and close at the will of the animal.

BIRADIOLITES, d'Orbigny, 1850. Ligamental groove visible in one or both valves, sometimes occupying the crest of a ridge, and bordered by two similar areas. Fossil, 5 sp. Chalk; France. *R. canaliculatus* (cxviii, 38).

LAPEIROUSIA, Bayle. *R. Jouanetti*, Desm.

SYNDONITES, Pirona, 1869. Cardinal teeth grown together almost in their entire length. *R. Stoppaniana*, Pir. Cret.; Friaul.

SPHÆRULITES, de la Merthe, 1805. (Acardo, Brug. Iodamia, Defrance. Birostrites, Lam. Dipilidia and Agria, Math. Heterocaprina, Munier-Chalmas.) Attached valve generally elongately conical with longitudinal, more or less foliated surface and the margins radiately ribbed, internally with a single umbonal rib extending the whole length of the valve. Free valve smaller, similar in form and structure to that of Radiolites, but with a median tooth or columella corresponding to the hinge-rib of the other valve, in which there is on each side of the rib a cartilage-process, the two cartilage-plates being sometimes united in front, and next to them are situated the raised muscular scars. *R. unisulcatus*, Matheron (cxviii, 39).

The presence of a hinge-rib readily distinguishes the present group from Radiolites (restricted), and the absence of any other ribs or folds in the attached valve separates it from Hippurites.

TAMIOSOMA, Conrad, 1856.

The type of this genus is a very peculiar fossil from the upper miocene deposits of California, *T. gregaria*, Conn. Gabb, in the second volume of the Palæontology of California (pp. 61–63), has very ably discussed the organization of this fossil, and comes to the conclusion that it is most likely a species of the Hippuritidæ. The specimens which have, up to the present, been found, resemble the elongated, lower valve of Hippurites with a small place of attachment apparently at the thinner or lower end. They are subcylindrical with rather thick walls consisting of two or three layers, possessing the same reticulated and striated structure as that of Radiolites, and others. The lower portion of the shell is composed of a large number of irregular chambers or septa which are produced by lateral prolongations of the inner wall. The end is occupied by a large cavity, similar to the "body-chamber" of Hippurites, but no impressions of teeth have as yet been observed in it. The outer surface is longitudinally striated in the type species which grows in clusters, as does, for instance, *H. organisans*, Defr.

In some respects Tamiosoma recalls the organization of the peculiar Hippurite from Jamaica, called by Woodward, Barrettia.

FAMILY MEGALODONTIDÆ.

Shell equivalve, very thick, mostly smooth or finely concentrically striated; hinge-plate broad and thick, with two strong teeth in each valve—sometimes bipartite; ligament external, supported by thick fulcra; posterior muscular impression usually upon a prominent ridge.

MEGALODON, J. Sowerby.

Etym.—*Megas*, large; *odos*, tooth.

Syn.—Megalodus, Goldfuss. Tauroceras, Schafh.

Distr.—Fossil, 14 sp. Upper Silurian—Devonian; United States, Europe. *M. cucullatus*, Sowb. (cxxii, 41).

Shell oblong, smooth or keeled; ligament external; hinge-teeth 1·2, thick; laterals 1·1, posterior; anterior adductor impression deep, with a raised margin, and a small pedal scar behind it.

In the typical species the beaks are subspiral, the lateral teeth obscure, and the posterior adductors bounded by prominent ridges.

[MEGALOMUS (*Canadensis*), Hall, 1852. Umbones very thick, hinge-teeth rugged, almost obliterated with age; posterior lateral teeth 1·1; no muscular ridges. Upper Silurian; Canada.]

EUMEGALODON, Gümbel, 1862. Shell elongated, sometimes longitudinally carinated; posterior cardinal tooth in the right valve smaller and widely bifid, corresponding tooth in the left valve very prominent and only grooved, posterior lateral tooth well-developed. *M. cucullatus*, Sowb.

NEOMEGALODON, Gümbel, 1862. Shell subtrigonal or cordiform, posterior cardinal teeth bifid in both valves, stronger in the left than in the right one, posterior lateral tooth indistinct or obsolete. Triassic. *M. triqueta*, Walfen.

PACHYMEGALODON, Gümbel, 1862. Posterior cardinal tooth single in the left, double and curved in the right valve, posterior lateral tooth short and distinct; anterior muscular impression posteriorly and inferiorly surrounded by a raised margin. Triassic. *M. chamæformis*, Gümbel.

PACHYRISMA, Morris and Lycett.

Etym.—*Pachus*, thick; *ereisma*, support.

Type, *P. grande*, Morris and Lycett (cxii, 39, 40). Great Oolite (Bathonian); Minchinhampton.

Shell cordate, with large subspiral beaks; valves very thick near the umbones, obliquely keeled; hinge with one thick conical tooth (behind the dental pit, in the right valve), a small lateral tooth close to the deep and oval anterior adductor, and a posterior lateral tooth (or muscular lamina?); ligamental plates short and deep.

CONCHODON, Stoppani, 1865.

Etym.—*Conchos*, a shell, and *odos*, a tooth.

Type, *C. infraliasicus*, Stop. Lower Lias; Lombardy.

Shell equivalve, symmetrical, very thick, cordiform, closed; beaks large, angulated, involute. Ligament internal, very long, marginal, attached to the posterior half of the hinge-plate. Hinge massive; in the right valve, one large rounded tooth in front (placed above a dental pit), and two transverse cardinal teeth; left valve with a large circular socket, bounded below by a curved lamellar tooth; two transverse and one curved teeth beneath the umbo.

DICEROCARDIUM, Stoppani, 1865.

Etym.—*Diceras*, having two horns, and *cardium*.

Distr.—Fossil, 4 sp. Upper Trias; Lombardy, Northwest Himalayas. *D. Jani*, Stop. (cxvii, 20, 21).

Shell equivalve, symmetrical, closed, free; umbones very prominent, elongated, or spiral. Hinge-plate broad, thick, separated by an interval of varying width from the edge of the valve, and prolonged into the umbonal cavity. Left valve with a compressed cardinal tooth, corresponding to a socket in the right valve; valves furrowed by ligamental grooves. Ligament external.

FAMILY TRIDACNIDÆ.

Shell regular, equivalve, truncated in front; ligament external; valves strongly ribbed, margins toothed; muscular impressions blended, subcentral, obscure.

Animal attached by a byssus, or free; mantle-lobe extensively united; pedal opening large, anterior; siphonal orifices surrounded by a thickened pallial border; branchial plain; anal remote, with a tubular valve; shell-muscle single, large and round, with a smaller pedal muscle close to it behind; foot finger-like, with a byssal groove; gills two on each side, narrow, strongly plaited, the outer pair composed of a single lamina, the inner thick, with margins conspicuously grooved; palpi very slender, pointed.

The shell of Tridacna is extremely hard, being calcified until almost every trace of organic structure is obliterated.

TRIDACNA, Bruguière, 1789.

Etym.—*Tri*, three; *dakno*, to bite; a kind of oyster. (Pliny.) Clam-shell.

Syn.—Chametrachæa, Klein, 1753.

Distr.—7 sp. Indian Ocean, China Seas, Pacific. Fossil, *T. media*. Miocene; Poland. Tridacna and Hippopus are found in the raised coral-reefs of Torres Straits. (Macgillivray.) *T. squamosa*, Lam. (cxxviii, 86–88). *T. crocea*, Lam. (cxxviii, 91).

Shell massive, trigonal, ornamented with radiating ribs and imbricating foliations; margins deeply indented; byssal sinus in each valve large, close to the umbo in front; hinge teeth 1·1, posterior laterals 2·1.

A pair of valves of *T. gigas*, weighing upwards of 500 pounds and measuring about two feet across, are used as benitiers in the Church of St. Sulpice, Paris. (Dillwyn.) Captain Cook states that the animal of this species sometimes weighs twenty pounds, and is good eating.

Axes of great size, weighing seven or eight pounds, are made from the thickest portion of the giant Tridacna by the natives of the Caroline Islands.—DR. J. C. COX.

HIPPOPUS, Lamarck, 1799. The "bear's-paw clam" has close valves with two hinge-teeth in each. It is found on the reefs in the Coral Sea. The animal spins a small byssus. *H. maculatus*, Lam. (cxxviii, 89–90).

EURYDESMA, Morris, 1845.

Distr.—*E. cordata*, Sowb. Devonian? N. So. Wales.

Shell oval or roundly cordate, rather thin, but very much thickened near the beaks, concentrically striated or nearly smooth; beaks strongly incurved, with a sort of an excavated and gaping lunette in front; ligament large, occupying the greater part of the posterior, more or less straight hinge-area, which is broad and extends below the beaks so as to make the ligament almost internal, one large subconical cardinal tooth in the right valve somewhat curved upward and corresponding to a pit in the left; several small muscular impressions near the hinge, but no other larger ones perceptible, neither has the pallial impression been as yet traced out.

(*Lucinacea.*)

FAMILY LUCINIDÆ.

Shell orbicular, free, closed; hinge-teeth 1 or 2, laterals 1—1 or obsolete; interior dull, obliquely furrowed; pallial line simple; muscular impressions two, elongated, rugose; ligament external or subinternal.

Animal with mantle-lobes open below, and having one or two siphonal orifices behind; foot elongated, cylindrical, or strap-shaped (ligulate), protruded at the base of the shell; gills one (or two) on each side, large and thick, oval; mouth and palpi usually minute.

The Lucinidæ are distributed chiefly in the tropical and temperate seas, upon sandy and muddy bottoms, from the seashore to the greatest habitable depths. The shell consists of two distinct layers. The family first appeared in the Silurian.

SUBFAMILY *LUCININÆ.*

Shell more or less orbicular, the anterior muscular impression narrower and much longer than the posterior, the ligament is lodged in a deep groove or is sometimes nearly internal.

LUCINA, Bruguière, 1792.

Etym.—*Lucina*, a name of Juno.

Distr.—100 sp. Universal. Fossil, 250 sp. U. Silurian—; United States, T. del Fuego, Europe, Southern India. *L. Jamaicensis*, Linn. (cxix, 40).

Shell orbicular, white; umbones depressed; lunule distinct; margins smooth or minutely crenulated; ligament oblique, semi-internal; hinge-teeth 2·2, laterals 1—1 and 2—2, or obsolete; muscular impressions rugose, anterior elongated within the pallial line, posterior oblong; umbonal area with an oblique furrow.

Animal with the mantle freely open below; siphonal orifices simple; mouth minute, lips thin; gills single on each side, very large and thick; foot cylindrical, pointed, slightly heeled at the base.

The foot of Lucina is often twice as long as the animal, but is usually folded back on itself and concealed between the gills; it is hollow throughout.

CYCLAS, Klein, 1753. (Divaricella, von Martens, 1880.) Valves divaricately striate *L. divaricata*, Lam. (cxix, 41). West Indies. *L. Rigaultiana*, Desh., a fossil of the Paris Basin, may also be added to this group.

CODAKIA, Scopoli, 1777. (Lentillaria, Schum., 1817. Jaconia, Recluz, 1869.) Shell flattened, surface radiately flatly ribbed or grooved. *L. tigerina*, Linn. (cxix, 42).

MILTHA, H. and A. Adams, 1856. Shell inequivalve, with nearly smooth surface; lateral teeth obsolete. *L. Childreni*, Gray (cxix, 43).

MYRTEA, Turton, 1822. (Cyrachæa, Leach.) Shell a little compressed, ribbed, crossed by scabrous concentric lines. Cardinal teeth one in one valve, two in the other. *L. scabra*, Lam. (cxix, 44, 45).

HERE, Gabb. Shell suborbicular, globose, concentrically striated, anterior lateral and cardinal teeth well developed, as in Lucina, but the lunule is very deep, extending across the hinge-area between the anterior lateral and the cardinal teeth. *L. Richthofeni*, Gabb (cxix, 46, 53). Tertiary; California. Two recent California species are included by Mr. Gabb in this group, the main character of which is the excavation of the lunule.

PARACYCLAS, Hall, 1843. May be a section of Lucina, but its hinge and other internal characters are unknown. 5 sp. Devonian; N. Y.

LORIPES, Poli, 1791.

Etym.—*Lorum*, a strap; *pes*, a foot.

Syn.—Lucinidea, d'Orb. Glissocolus, Gabb, 1869.

Distr.—25 sp. Atlantic, Mediterranean, West Indies. Fossil. Eocene—; France. Cret.; California. *L. edentula*, Linn. (cxix, 47).

Animal with the margin of the mantle notched; incurrent tube long.

Shell almost equilateral, cancellated, or sculptured by flexuous striæ; lunule short; cartilage *quite internal;* teeth, one cardinal in the right, and two in the left valve; laterals remote, and sometimes indistinct.

AUSTRIELLA, Tenison-Woods, 1881. A rounded-oval shell, with concentric lamellæ, covered by a brown epidermis which extends over the interior side around the margin, forming a broad band; hinge thick, with an inconspicuous arcuate smooth tooth; interior surface white with radiating obsolete ribs, not nacreous, without pallial sinus.

A. sordida, Tenison-Woods. Port Denison, Australia, in fresh- or brackish-water swamps. This shell was supposed by the describer to belong to the family Unionidæ, and to be closely allied to Spatha, but it is evident he is not acquainted with the latter genus. Judging from the description and figure it appears to me to be a Lucinoid shell, closely allied to if not identical with Loripes.

CRYPTODON, Turton, 1822.

Syn.—Axinus, J. Sowerby, 1823. Thysaira, etc., Leach. Bequania, Leach. Ptychina, Philippi, 1836. Thiatyra, G. Sowb.

Distr.—16 sp. Europe, etc. Fossil, 3 sp. Eocene; United States, Europe. *C. flexuosus*, Montf. (cxix, 48).

Animal with the mantle-margin thickened, open, not prolonged into tubes; foot long, subcylindrical, and very slender.

Shell globular, posterior side furrowed or angulated, umbones much recurved; lunule short or indistinct; ligament usually and to a certain extent external, placed in a groove on the hinge-line, and outside the hinge-plate; teeth altogether wanting.

In *C. flexuosus*, the hinge-plate is indented in the right valve immediately below the beaks, and slightly reflected in the left, which gives that valve the appearance of having an indistinct or obscure cardinal tooth.

PHILIS, Fischer, 1864.

Distr.—*P. Cumingii*, Fischer (cxix, 49, 50). Moluccas.

Shell ovate, higher than long, inflated, thin, finely concentrically striated and with a posterior duplicature extending from the beaks; hinge edentulous, lunula small and very deep, forming a

kind of a roundish or spoon-shaped process below the beaks; muscular impressions rounded.

SUBFAMILY *CORBINÆ*.

Shell generally elongately ovate, or ovately rounded, solid, with muscular impressions subequal, broadly ovate, the ligament always external.

CORBIS, Cuvier, 1817.

Etym.—*Corbis*, a basket.

Syn.—Fimbria, Mühl., 1811, not Bohadsch. Idotæa, Schum., 1817. Gafrarium, Bolten, 1798.

Distr.—5 sp. India, China, North Australia, Pacific. Fossil, 80 sp. (including subgenera). Lias—; United States, Europe. *C. fimbriata*, Linn. (cxix, 51).

Shell oval, ventricose, subequilateral, concentrically sculptured; margins denticulated within; hinge-teeth two, laterals two, in each valve; pallial line simple; umbonal area with an oblique furrow, muscular impressions round and polished; pedal scars close to adductors.

Animal with the mantle open below, doubly fringed; foot long, pointed; siphonal opening single, with a long retractile tubular valve; lips narrow; palpi rudimentary; gills single on each side, thick, quadrangular, plaited, united behind.

In *C. dubia* (Semicorbis), Desh., from the Eocene, Paris, the lateral teeth are obsolete.

SPHÆRA, Sow., 1822. (Palæocorbis, Conrad, 1869.) Shell ovate, inflated, solid, subequilateral; hinge of left valve with two blunt cardinal teeth, the posterior much smaller and separated from the larger anterior by a pit; lunular edge somewhat extended with a deep pit and a swollen tooth-like margin above and below it; posteriorly with a furrow near the fulcral margin and several cross-teeth at the posterior end; ligament in a long excavated furrow. Type, *C. corrugata*, Sowb. (cxix, 52). Neocomian.

MUTIELLA, Stolicz., 1870. Shell oblong, subequilateral, tumid, with obtuse incurved beaks; hinge in the left valve with two cardinal teeth, the anterior one being sometimes bifid, in the right valve there is a single large bifid cardinal tooth; lunular edge expanded, with several teeth, or with more or less distinct corrugations, representing anterior lateral tooth; posterior hinge side straight with a furrow near the margin for the ligament, and an indistinct terminal posterior lateral tooth. *C. coarctata*, Zitt. (cxix, 56, 57). This group differs essentially by the characters of the hinge from the previous; there are several middle and upper cretaceous species which belong to it, but none are known from more recent deposits.

SPHÆRIOLA, Stoliczka, 1870. Shell rounded, globose, nearly equilateral, with concentric striæ or sulci on the surface; hinge

with two diverging cardinal teeth in each valve, the anterior being somewhat elongated and nearly horizontally extended. The absence of lateral teeth and the usual rounded and globose form readily distinguishes this group from Corbis. The group has been mistaken for Sphæra, under which name also most of the species appear to have been described. Triassic, Cretaceous. *C. Mellingi*, Hauer (cxix, 54, 55).

UNICARDIUM, d'Orbigny, 1852.

Syn.—Mactromya, Agass. (part).

Distr.—Jurassic and Cretaceous. *U. impressum*, Morris and Lycett (cxix, 58).

Shell transversely oval, smooth or concentrically striate; hinge with a single cardinal tooth in each valve, and no lateral teeth.

GONODON, Schafhaeutl, 1863. Shell ovate, tumid, apparently smooth; hinge of the right valve with a very large median semicircular broad tooth with the sharpened edge turned upwards, that of the left valve with an equally large corresponding pit below bounded by a long thick tooth somewhat smaller than that of the other valve; the posterior margins of the hinge are thickened in both valves. This group differs from Unicardium by the enormous development (natural?) of the teeth. Type, *U. ovatum*, Goldfuss. Lias.

CONCHOCELE, Gabb, 1866.

Type, *C. disjuncta*, Gabb. Tertiary; California.

Shell subquadrate, posteriorly less high and elongated, being very inequilateral, a ridge passing from the beaks to the posterior end; hinge edentulous, hinge-area somewhat thickened and insinuated under the beak with a single long rib-like tooth extending from the beak to the posterior end. As to internal characters this genus hardly appears to differ from some forms of Unicardium in which the cardinal tooth is obsolete, but the shape of the shell is different.

FIMBRIELLA, Stoliczka, 1870.

Type, *F. lævigata*, Sowb. (cxix, 59). Cretaceous; England.

Shell suborbicular, moderately tumid, subequilateral, with prominent, obtuse, incurved beaks, surface partially smooth, partially finely punctate or spinulous; lunular edge in front of the beaks somewhat expanded, hinge in each valve with two conical or subtubercular cardinal teeth: those of the right are superimposed, the upper one being situated on the enlarged lunular margin, those of the left valve are situated beside each other, the anterior much stronger than the posterior, no lateral teeth are present, but the margin is posteriorly internally slightly

grooved; the ligament must have been thin, for there is only a short very narrow space immediately behind the beaks for its attachment, no special nymphæ being present.

Differs from Unicardium in the number and position of the hinge-teeth.

CORBICELLA, Morris and Lycett, 1853.

Etym.—Diminutive of *Corbis.*

Distr.—Fossil, 7 sp. Upper part of Inferior Oolite—Oxfordian; England, France. *C. subæquilatera*, Lycett (cxix, 60).

Shell destitute of ornament, ovately elongated, rather compressed; anterior side small; hinge characters differ from those of Corbis, in the absence of the anterior lateral tooth, and in the oblique internal ridge passing downwards behind the anterior muscular scar.

Corbicella is intermediate between Corbis and Tancredia; and from the latter, to which it is more nearly allied, it is separated by its more ovate form, and by the absence of the posterior oblique angle, and in the possession of a lengthened hinge-lamina and depressed remote posterior lateral tooth.

Morris and Lycett state the anterior lateral tooth is always wanting, but though not well developed, it is certainly indicated by the internally strongly thickened margin in such species as *Corb. depressa*, Desh., and still more in *Corb. Barrensis*, Buv.

SPORTELLA, Deshayes, 1852.

Distr.—Fossil, 17 sp. Tertiary; Paris Basin. *S. Cailleti*. Desh. (cxix, 61).

Shell oblong, smooth, depressed, subequilateral; valves closed. Hinge narrow, with two unequal, diverging teeth in the left valve, one in the other; the lateral teeth are wanting. Muscular scars large, oval, nearly equal; pallial line simple. Ligament external.

Possibly some of the Liassic species referred to Unicardium belong to this genus.

SPHÆRELLA, Conrad, 1838.

Distr.—3 recent sp. California, Guayaquil, N. Zealand. Cretaceous, Tertiary; United States, Europe. *C. concentrica*, Conr. (cxix, 63).

Shell rounded, tumid, thin; hinge with two cardinal teeth in each valve, the posterior one in the right valve broad, bifid, parallel to the hinge-margin, in the left single, but equally elongated. Some of the palæozoic Lucinæ may belong to this genus. Conrad and others class it near Diplodonta, but the prolonged posterior teeth appear to indicate a greater relation for the various Corbinæ.

TANCREDIA, Lycett, 1850.

Etym.—Dedicated to Sir Thomas Tancred, Bart., founder of the Cotteswold Naturalists' Club.

Syn.—Hettangia, Terquem. Palæomya, Zitt. and Goub., 1861

Distr.—Fossil, 12 sp. Lias — Bath Oolite; Britain, France. *T. Dionvillensis*, cxix, 65). *T. curtansata*, M. and L. (cxix, 66). *T.* (*Palæomya*) *Deshayesii* (cxix, 64).

Shell trigonal, smooth; anterior side usually longest; cardinal teeth 2·2, one of them small; a posterior lateral tooth in each valve; ligament external; muscular impressions oval; pallial line simple.

This genus is closely related to Meekia of Gabb, Cretaceous, California, but differs in being closed instead of gaping anteriorly, as well as in wanting the peculiar anterior angularity of that type; which also presents some differences in the nature of its hinge-plate, and is said to have its ligament subexternal instead of decidedly external.

MEEKIA, Gabb, 1864.

Distr.—3 sp. *M. radiata*, Gabb (cxix, 67). Cretaceous; California.

Shell oblong, subinequilateral, posteriorly rounded, anteriorly somewhat produced and turned upwards hook-like, terminating in a point; surface marked with striæ of growth only; hinge with two robust, triangular teeth on the right valve, and one large and one small one on the opposite side, the large one being received between the two of the right valve; posteriorly on each side is an indistinct lateral tooth. A short robust plate separates the anterior muscular scar from the cavity of the beak.

FAMILY UNGULINIDÆ.

Shell suborbicular, closed, sometimes a little irregular; hinge composed of two bifid, divergent cardinal teeth, and no laterals; ligament marginal, mantle-margins united, with pedal and anal openings; foot vermiform.

UNGULINA, Daudin.

Etym.—*Ungulina*, like a hoof.

Syn.—Clotho, Basterot, non Faujas.

Distr.—4 sp. Senegal, Philippines, excavating winding galleries in coral. ? Carboniferous, Miocene. *U. oblonga*, Daud. (cxix, 68).

Shell suborbicular; ligament very short; epidermis thick, wrinkled, sometimes black; hinge-teeth 2·2; muscular impressions long, rugose.

Animal with the mantle open below, fringed; siphonal orifice single; foot vermiform, thickened at the end and perforated,

projecting from the base of the shell or folded up between the gills; palpi pointed; gills two on each side, unequal, the external narrower, with a free dorsal border, inner widest in front.

AXINOPSIS, Sars, 1878.

Distr.—*A. orbiculata*, Sars (cxix, 69, 70). Norway.

Shell discoidal, tumid in the middle, compressed towards the margins; umbones slightly prominent; no external ligament; valves thin, pellucid, white, concentrically striate; cardinal tooth in the right valve obtusely elevated, recurved, in the left valve elongated, subhorizontal; cartilage narrow.

MYSIA, Leach, 1819 (Brown, 1827).

Syn.—Diplodonta, Brown, 1831.

Distr.—40 sp. West Indies, Rio, Britain, Mediterranean, Red Sea, West Africa, India, Corea, Australia, California. Fossil, 30 sp. Cretaceous, Eocene—; United States, Europe. *M. Brasiliensis*, Phil. (cxix, 71).

Shell suborbicular, smooth; ligament double, rather long, submarginal; hinge-teeth 2·2, of which the anterior in the left valve, and posterior in the right are bifid; muscular impressions polished, anterior elongated.

Animal with the mantle-margins nearly plain, united; pedal opening large, ventral; foot pointed, hollow; palpi large, free; gills two on each side, distinct, the outer oval, inner broadest in front, united behind; branchial orifice small, simple; anal larger, with a plain valve.

TENEA, Conrad, 1870. Shell roundly ovate, thin, tumid; left valve under the apex with a V-shaped tooth, the anterior lobe of which is continued along the anterior margin of the shell, separated by a deep groove from it; in the right valve are two cardinal teeth united above, the anterior is falcate, with a pit on each side, the posterior curved and directed obliquely backwards. *M. parilis*, Con. (cxix, 72).

FELANIA, Recluz, 1851. Shell sublenticular, equivalve, equilateral, thin, with an epidermis; beaks and lunule small; two divergent subapical teeth, the posterior of the right and anterior of the left valve channeled or bifid; no lateral teeth, but in place of them a deep, long groove on each side the cardinals; ligament cartilaginous, very long; muscular impressions oval-oblong; pallial line with a short trigonal sinus. 10 sp. *M. rosea*, Recluz (cxix, 73, 74).

HIPPAGUS, Lea, 1833.

Distr.—*H. Isocardioïdes*, Lea. Eocene; Ala.

Shell ovate, higher than long, tumid, with prominent, attenuated incurved beaks; of moderate thickness; internal and external superficial layers of a silky appearance; hinge edentu-

lous, with a simple insinuation or a slight notch; ligamental furrow subinternal; lunule not excavated; muscular impressions ovate, marginal.

PSATHURA, Deshayes, 1860.

Etym.—ψαθυρὸς, friable.

Type, *Erycina fragilis*, Lamk. (cxx, 76, 78). Eocene; Paris Basin.

Shell oval, inequilateral, thin, transparent, fragile; hinge-teeth, in the right valve, two equal and deeply bifid; left valve, two unequal, entire; ligament external; anterior adductor scar narrow, claviform; posterior subquadrangular; pallial line simple, thus differing from Clementia, to which it is related by the hinge-characters.

SCACCHIA, Philippi, 1844.

Distr.—2 sp. Mediterranean. Fossil, 1 sp. Pliocene; Sicily. *S. elliptica*, Phil. (cxix, 75).

Shell minute, ovate, posterior side shortest; hinge-teeth 1 or 2, laterals obsolete; ligament minute; cartilage internal, in an oblong pit.

Animal with mantle widely open; siphonal orifice single; foot compressed, linguiform; palpi moderate, oblong.

FAMILY ERYCINIDÆ.

Shells very small, thin, fragile, usually transparent, and sometimes gaping, rounded or transverse, laterally depressed; hinge narrow, with one or two cardinal teeth, the laterals more or less elongated, compressed, sometimes wanting; muscular impressions small, not well-marked; pallial line simple.

ERYCINA, Lam., 1804.

Distr.—12 sp. Fossil, 50 sp. Cret.—Eocene—; N. Am., Paris Basin. *E. Geoffroyi*, Payr. (cxx, 25–27).

Shell equivalve, subinequilateral, usually transversely oval; one, or two unequal, diverging cardinal teeth, separated by a pit; lateral teeth oblong, compressed, short; ligament external and internal; muscular impressions rounded, pallial line simple.

ERYCINELLA, Conrad, 1845.

Distr.—*E. ovalis*, Conr. Miocene; Virginia (cxx, 62); and Crag; England (cxx, 79, 80).

Shell subtrigonal, inequilateral, thick; two cardinal teeth, separated by a pit in each valve; lateral teeth rudimentary; ligament internal; pallial line simple.

SPANIODON, Reuss, 1867.

Type, *S. nitidus*, Reuss (cxx, 83, 84). Miocene; Galicia.

Shell roundly subtrigonal, with somewhat produced obtuse beaks, nearly equilateral; surface only concentrically striated; hinge with an anterior (sublunular) elongated cardinal tooth in each valve, in the right separated from the margin by a deep groove; cartilage in a pit situated below and a little posterior to the beaks; muscular impressions rather large, equal.

MONTACUTA, Turton.

Etym.—Dedicated to Colonel George Montagu, the most distinguished of the earlier English malacologists.

Syn.—Montaguia, Forbes.

Distr.—12 sp. United States, Norway, Britain, Mazatlan. Ægean. *M. substriata*, Forbes (cxx, 85). Fossil, 2 sp. Pliocene—; Britain.

Shell minute, thin, oblong, anterior side longest; hinge-line notched; ligament internal, between two laminar, diverging teeth (with a minute ossicle. Lovén).

Animal with the mantle open in front; margins simple; siphonal orifice single; foot large and broad, grooved.

The Montacutæ moor themselves by a byssus, or walk freely; *M. substriata* has only been found attached to the spines of the purple heart urchin (*Spatangus purpureus*) in 5–90 fathoms. *M. bidentata* burrows in the valves of dead oyster-shells.

The byssal threads by which this curious mollusk attaches itself are exceedingly coarse and strong. Mr. Clark observed it in active motion after he had separated it, still adhering to the spines, from a *Spatangus*. He says: "When the animal marches, its foot is extended, and its rounded termination is instantly fixed to the vase in which it is deposited; then by the retractor muscle it is drawn forward, making such rapid progression as to cross a watch-glass in a minute, and on the passage turns itself several times by a twist of the foot from side to side.

"The gills and green liver are visible through the shell in some specimens which are more transparent than others, the former crossing it diagonally. The shape and position of the cartilage is very remarkable. Sometimes the shell is partly incrusted with a ferruginous deposit. The number of fry, with their shells completely formed, which are found in some individuals, is astonishing. Many hundreds of them, packed close together, and glittering like microscopic pearls, might be counted. They occupy at least two-thirds of the space enclosed within the valves of their parent; and its own body seems to be atrophied and dwindled to a mere skeleton. The shell is in fact turned into a crowded nursery. Perhaps the parent dies, like some insects, immediately after all its progeny have been developed. I do not concur in the general belief that *M. substriata* is para-

sitic. In one sense only can it be said to live on echinoderms. The food of *Spatangus purpureus*, on which it is usually found, appears to consist of animalculæ; and for that purpose it swallows large quantities of shell-sand, causing thereby a strong and frequent current in the neighborhood of its mouth. The Montacuta probably avails itself of this in-draught, and partakes of the sustenance intended for the Spatangus, placing itself in the way, with its alimentary tube or opening turned in the right direction. No exudation of the Spatangus has been noticed; and its excretions would scarcely be produced in sufficient quantity for the support of the Montacuta, or perhaps be suitable to it. The latter has no suctorial organ, such as is possessed by all animal parasites; it never attaches itself to the pedicellariæ or any other soft part of the echinoderm; nor has it once been detected on the back or sides, or elsewhere than in the ventral region of its associate. It is only found on the spines close to their points."—JEFFREYS.

TELLIMYA, Brown, 1827. Shell transversely oval, surface a little rugose; beaks prominent, acute; hinge with a pit for the ligament, which contains a small ossicle, and a triangular cardinal tooth on each side of it in the right valve, and two distant rudimentary lateral teeth in the left valve. *T. bidentata*, Mont. (cxx, 86). Europe. 6 sp. Eur., Cal., Japan.

KELLIELLA, M. Sars.

Distr.—*K. miliaris*, Phil. (cxx, 87–89). Europe.

Shell minute, orbicular, tumid; umbones slightly prominent, incurved; lunule cordate, distinct; ligament minute; surface white, without epidermis, concentrically striate; cardinal teeth two, laterals none.

LASÆA, Brown, 1827.

Syn.—Poronia, Recluz, 1843. Cycladina, Cantr. (pars). Kellia (pars). Bornia (pars).

Distr.—9 sp. Universal. Fossil; Tertiary. *L. rubra*, Mont. (cxx, 90).

Animal with the mantle folded on the anterior side so as to form a wide but incomplete incurrent tube; the excurrent tube is inconspicuous, placed on the opposite side; foot long.

Shell minute and roundish oval; beaks straight; cartilage long, placed at the shorter end of the shell, contrary to that in Kellia; left valve with a minute thorn-like cardinal tooth; and in each valve two remarkably strong lateral teeth.

The genus is intermediate between Montacuta and Kellia.

"The Lasææ usually inhabit the littoral zone, where they congregate in vast numbers at the roots of small sea-weeds, in the crevices of rocks, and in empty shells. *L. rubra*, a British spe-

cies, is viviparous, and lives as much out of the sea as in it. Other species occur in various parts of the world."—JEFFREYS.

LEPTON, Turton.

Etym.—*Lepton*, a minute piece of money (from *leptos*, thin).

Syn.—? Solecardia (*eburnea*), Conrad, 1849.

Distr.—20 sp. Universal. Laminarian and coralline zones. Fossil, 5 sp. Eocene—; United States, Europe. *L. squamosum*, Mont. (cxx, 61).

Shell suborbicular, compressed, smooth, or shagreened, a little opened at the ends and longest behind; hinge-teeth 0·1 or 1·1 in front of an angular cartilage-notch; lateral teeth 2·2 and 1·1.

Animal with the mantle open in front, extending beyond the shell, and bearing a fringe of filaments, of which one in front is very large; siphon single, gills two on each side, separate; foot thick, tapering, heeled and grooved, forming a sole or creeping disk.—ALDER.

PRISTOPHORA, Carpenter, 1866.

Distr.—*P. oblonga*, Carp. San Diego, Cal.

Shell oval, with two diverging teeth in each valve, the anterior being conspicuously shorter than the posterior, sulcated near the beaks, ligament situated in a groove between them.

KELLIA, Turton, 1822.

Etym.—Named after Mr. O'Kelly, of Dublin.

Syn.—Cycladina (Adansonii), Cantr.

Distr.—35 sp. Norway, New Zealand, California. Fossil, 20 species. Eocene—; United States, Europe. *K. suborbicularis*, Mont. (cxx, 92).

Shell small, thin, suborbicular, closed; beaks small; margins smooth; ligament internal, interrupting the margin (in *K. suborbicularis*), or on the thickened margins (in *K. rubra*); cardinal teeth 1 or 2, laterals 1—1 in each valve.

Animal with the mantle prolonged in front into a respiratory canal, either complete (in *K. suborbicularis*) or opening into the pedal slit (in *K. rubra*); foot strap-shaped, grooved; gills large, two on each side, united posteriorly, the external pair narrower and prolonged dorsally; palpi triangular; posterior siphonal orifice single, exhalent.

The hinges of these little shells are subject to variations, which are not constantly associated with the modifications of the mantle-openings. They creep about freely, and fix themselves by a byssus at pleasure. *K. rubra* is found in crevices of rocks at high-water mark, and often in situations only reached by the spray, except at spring-tides; other species range as deep as 200 fathoms. *K. Laperousii* (Chironia), Desh., was obtained, burrowing in sandstone, from deep water, at Monterey, California.

BORNIA, Philippi, 1836. Shell elongately oval, with slightly projecting beaks, almost equilateral, surface finely concentrically striated; hinge with three teeth in the left valve, two small anterior and one somewhat remote and elongated posterior, right valve with only two diverging elongated cardinal teeth; cartilage situated in a groove in front of the posterior teeth; muscular impressions faintly marked. *K. corbuloides*, Phil., occurs recent in the Mediterranean and the Atlantic, and fossil in miocene beds of Italy and the Vienna Basin. *K. seminula*, Phil. (cxx, 93–95).

CYCLADELLA, Carp., 1865. Shell resembling Œdalina in form, thin, umbones flattened; ligament external, very thin; the cardinal teeth lie in the curve of the hinge-line, together with the laterals, which are distant.

PYTHINA, Hinds. (Myllita, d'Orb. and Recl.) Shell trigonal, divaricately sculptured; ligament internal; right valve with two lateral teeth, left with one cardinal and two laterals. 13 sp. New Ireland, Australia, Philippines. Fossil, 2 sp. Eocene; France, Java. *P. Deshayesiana*, Hinds (cxx, 96).

CYAMIUM, Philippi, 1845.

Distr.—3 sp. Patagonia, Northern Europe, U. S. Fossil, 1 sp. Tertiary; Europe. *C. Antarcticum*, Phil. (cxx, 97).

Shell oblong; hinge-teeth, 2·2; ligament double; cartilage in a triangular groove behind the teeth in each valve.

TURTONIA, Hanley. Shell oblong, inequilateral, anterior side very short; ligament concealed between the valves; hinge-teeth 2·2. Animal with the mantle open in front; foot large, heeled; siphon single, slender, elongated, protruded from the long end of the shell. Greenland, Norway, Britain; in pools and crevices of rocks between tide-marks, and in the roots of sea-weeds and corallines. Mr. Thompson obtained them from the stomachs of mullets taken on the northeast coast of Ireland. *T. minuta*, Hanley (cxx, 98, 99).

HINDSIELLA, Stol., 1870. (Hindsia, Desh., 1860. Vasconia, Fischer.) Shell elongately subtriangular, nearly equivalve, with the lower margin insinuated, hinge with one or two (generally one in the right, two in the left) minute cardinal teeth in each valve; ligament external, supported by thin fulcra; muscular impression narrow, elongated, pallial line rather broad, simple. *C. lobata*, Desh. (cxx, 100). Grignon.

THECODONTA, A. Ad., 1864.

Distr.—*Th. Sieboldi*, A. Ad. China Seas.

Shell oblong, very inequilateral, the anterior part being shorter than the posterior, concentrically sulcated; hinge in the left valve with two diverging cardinal teeth with a cup-like projecting fold between them, a single posterior lateral tooth present;

pallial line single and radiately grooved, anterior muscular scar triangular, posterior oval.

GALEOMMA, Turton

Etym.—*Galee*, weasel; *omma*, eye.

Syn.—Hiatella, Costa (not Daud.). Parthenopea, Scacchi (not Fabr.).

Distr.—14 sp. Britain, Mediterranean, Mauritius, Pacific. Fossil, 1 sp. Pliocene—; Sicily. *G. Turtoni*, Forbes and Hanley (cxx, 1).

Shell thin, oval, equilateral, gaping widely below; invested with a thick, fibrous epidermis; beaks minute; ligament internal; teeth 0·1.

Animal with the mantle-lobes united behind and pierced with one siphonal orifice, margins double, the inner with a row of eye-like tubercles; gills large, subequal, united behind; palpi lanceolate, plaited; foot long, compressed, with a narrow flat sole.

The Galeomma spins a byssus, but breaks from its mooring at will and creeps about like a snail, spreading out its valves nearly flat.—CLARKE.

THYREOPSIS, H. Ads., 1868. Shell resembling Galeomma, nearly equilateral, subtriangular, beaks slightly tumescent, and with the whole of the ventral margins widely gaping. *G. coralliophaga*, H. Ad. (cxx, 2, 3). Mauritius.

SCINTILLA, Desh.

Distr.—53 sp. Philippines, North Australia. Fossil; Eocene. *C. Philippinensis*, Desh. (cxx, 4).

Shell transversely oval, obtusely rounded at the sides, equilateral, thin, shining, sometimes a little gaping; ligament internal, oblique; two diverging cardinal teeth in the left valve, one in the right valve; lateral teeth posterior, one in the right, two in the left valve; pallial impression simple.

PASSYA, Deshayes, 1852.

Distr.—*P. Eugenii*, Desh. (cxx, 5). Eocene; Paris Basin.

Shell regular, modioliform, triangular, depressed, greatly gaping on both sides; beaks anterior; hinge short and narrow, with a single tuberculiform tooth; ligament internal? muscular impressions small, submarginal; pallial line simple.

LIBRATULA, Pease, 1865.

Distr.—*L. plana*, Pse. On coral, Pacific Isles.

Semilunar, much compressed (like a Placuna), slightly gaping all round, cardinal margin crenulated, cartilage median, internal.

(*Solemyacea.*)

FAMILY SOLEMYIDÆ.

Shell elongated, transverse, equivalve, regular, very inequilateral, gaping, thin, covered (in Solemya, the recent genus) with a thick epidermis, extending beyond the shell-margins as a fringe; hinge toothless; ligament inserted in an oblique process and hidden; pallial line simple. Along with Solemya have been associated a number of fossil forms agreeing generally in the shape of the shell, yet by no means of certain relationship with it.

SOLEMYA, Lamarck, 1818.

Syn.—Solenomya, Menke, 1828. Janeira, King.

Distr.—6 sp. United States, Canaries, West Africa (Gaboon River), Mediterranean, Australia, New Zealand; burrowing in mud; 2 fathoms. Fossil, 4 sp. Carb.—; Britain, Belgium. 2 Cret. sp.; N. America. *S. Australis*, Lam. (cxxiii, 63).

Shell elongated, cylindrical, gaping at each end; epidermis dark, horny, extending beyond the margins; umbones posterior; hinge edentulous; ligament concealed; pallial line obscure. Outer layer of long prismatic cells, nearly parallel with the surface, and mingled with dark cells, as in Pinna; inner layer also cellular.

Animal with the mantle-lobes united behind, with a single siphonal orifice, hour-glass shape, and cirrated; foot proboscidiform, truncated and fringed at the end; gills forming a single plume on each side, with the laminæ free to the base; palpi long and narrow, nearly free.

CLINOPISTHA, Meek and Worthen, 1870.

Distr.—*C. antiqua*, Meek (cxx, 16, 17). Devon.; Ohio. *C. radiata*, Hall. Carb.; Ills.

Shell transversely oval, very thin, rather ventricose, equivalve, very inequilateral; beaks near the posterior extremity and directed backward, that of the right valve with its immediate apex curving under the beak of the left, which seems to be a little excavated for the reception of the same; ligament external, short, rather prominent, and occupying an oval or lance-oval shallow cavity, formed by the slight inflection of the margins of the valves immediately behind the beaks; valves with their margins smooth within and closed all around; hinge apparently edentulous; surface smooth, with growth-lines and sometimes traces of fine radiating lines; muscular impressions shallow; pallial line slightly marked, without sinus.

Differs from Solemya in its short gibbous form, want of internal ridge, closed margins, entirely external ligament, ventricose beaks, and their posterior position.

(*Carditacea.*)

FAMILY CRASSATELLIDÆ.

Shell oblong, posteriorly usually somewhat produced, mostly concentrically striated or sulcated, covered with an epidermis; hinge with a few cardinal teeth, and a cartilage-pit in both valves; lateral teeth, when present, slightly developed, elongated; pallial line entire.

CRASSATELLA, Lamarck, 1799.

Etym.—*Crassus*, thick.

Syn.—Pachythærus and Scambula, Conrad.

Distr.—34 sp. Australia, New Zealand, Philippines, India, West Africa, Canaries, Brazil. Fossil, 64 sp. Cret.—; Patagonia, United States, Europe. *C. Antillarum*, Reeve (cxxiii, 64).

Shell solid, ventricose, attenuated behind, smooth or concentrically furrowed; lunule distinct; ligament internal; margin smooth or denticulated; pallial line simple; hinge-teeth 1·2, striated, in front of cartilage-pit; lateral teeth 0—1, 1—0; adductor impressions deep, rounded; pedal small, distinct.

Animal with mantle-lobes united only by the branchial septum; inhalent margins cirrated; foot moderate, compressed, triangular, grooved; gills smooth, unequal, outer semilunar, inner widest in front; palpi triangular.

In *Crassatella pulchra* the animal is like Astarte; foot linguiform, slightly grooved; palpi short and broad, few-plaited; outer gill narrower in front.

CRASSITINA, Weinkauff, 1881. Proposed for the smaller species, with crenated margins of the valves.

PTYCHOMYA, Agassiz, 1842.

Syn.—Radioconcha, Conrad, 1869. Pleuroconcha, Conrad, 1872.

Distr.—Oolitic, Cretaceous; Europe, U. S. *T. plana*, Agass.

Shell ovately elongated, moderately compressed, beaks close together, placed subanteriorly, surface radiately ribbed, anteriorly generally divaricately striated; hinge with three diverging cardinal teeth in each valve, and the cartilage-pit situated in front of them; muscular impressions elongately oval, rather large; pallial line truncate posteriorly.

ANTHONIA, Gabb, 1864.

Distr.—*A. cultriformis*, Gabb (cxxi, 61, 62). Cretaceous; California.

Shell narrow, compressed, posteriorly very elongated, anteriorly shortly rounded, beaks obtusely pointed; hinge with two elongated, somewhat diverging cardinal teeth in each valve; a

pit is seen posterior to them in both valves, and judging from the general resemblance of the shell to Crassatella, it is probably destined to receive a cartilage.

PRONOË, Agassiz, 1843.

Syn.—Venulites, Schloth.

Distr.—Liassic; Europe. *P. triangularis*, Schloth.

Shell subtrigonal, like an Astarte or Cytherea, with slight concentric striation on the surface; hinge of the right valve with two cardinal teeth, the anterior one extending somewhat below and forming the margin of an elongated pit, above which there is a small sublunular tooth; a small oblique cartilage-pit is situated just behind the beak and a large remote posterior lateral tooth is also present; fulcrum strongly thickened. The hinge of the left valve must possess two cardinal and one sublunular and one posterior double lateral teeth. If Quenstedt's figure and description of the hinge of *P. triangularis*, Schloth., is correct, this would be the oldest form of Crassatellidæ, though, as that author remarks, the hinge-teeth of the right valve very much resemble those of a Cyprina; and should it be proved that the small pit is only an accidental depression in which a part of the external ligament is situated, the generic name would have to be cancelled, and the species referred to Cyprina, with which the shell perfectly agrees in form.

CRASSATELLINA, Meek, 1871.

Syn.—Etea, Conrad, 1873.

Distr.—*C. oblonga*, Meek (cxxi, 7–9). Cret.; U. S.

Shell transversely trapezoidal, equivalve, inequilateral, with free margins closed and smooth within; hinge with two cardinal teeth, and one elongated anterior and one posterior lateral tooth in each valve; anterior cardinal tooth of the left valve trigonal, and deeply emarginate below; posterior very much compressed, oblique, and somewhat elongated; cardinal teeth of right valve diverging, with a triangular pit between for the reception of the larger triangular tooth of the other valve; anterior one small, oblique, and connected at its upper end with the posterior extremity of the anterior lateral; posterior larger, oblique, longitudinally furrowed, and perhaps emarginated below, while just behind and above it there is a narrow oblique slit or pit, for the reception of the thin anterior cardinal of the other valve; lateral teeth elongated parallel to the cardinal margins; the anterior one of the right valve, and the posterior of the left, apparently continued so as to connect with the upper ends of the cardinal teeth; ligament external; pallial line simple.

ERIPHYLA, Gabb, 1864.

Syn.—Dozyia, Bosquet, 1868. Gouldia, C. B. Ad. (in part).

Distr.—Recent and Cretaceous; N. Am., Eur. *E. umbonata*, Gabb (cxxi, 11–13).

Shell suborbicular, moderately compressed, with pointed, approximate beaks, with a deep narrow lunule, in external character resembling Dosinia; muscular impressions large, but not deeply impressed, pallial sinus moderate, roundish, slightly ascending; hinge strong, in the right valve with two cardinal teeth, the central one strong and thick, often grooved, the anterior thinner and marginal; in the left valve also with two cardinal teeth, the subanterior thick, the posterior thinner; one small anterior lateral (lunule) tooth of the left valve fits into a corresponding pit of the right, and another small longish posterior and remote one of this valve into a corresponding cavity of the left valve. The best known species is *Lucina lenticularis*, Goldf., from the cretaceous beds near Aachen.

This is a very different shell from Dosinia as regards hinge-teeth as well as the form of the pallial sinus. It appears very probable that some of the Jurassic Astartes (*A. excavatum* and others), belong to this genus, but a very careful examination of the hinge and of the pallial line, which is broad, though very faint, and also of its sinus, will be necessary. The hinge-teeth of Eriphyla closely approach those of Astarte, but these have no distinct lateral teeth, nor a deep lunule or sinus. It is now generally recognized as a Crassatellid genus.

Family ASTARTIDÆ.

Shell thick, solid, equivalve, the cardinal teeth always well-developed, 2–3 in each valve; lateral teeth sometimes present on one or both sides, ligament always external, strong; muscular scars ovate, the anterior usually with a small deep superimposed pit, produced by the retractile muscle of the foot; pallial line entire.

Subfamily *ASTARTINÆ*.

Shell subtrigonal or roundly oval, with a smooth, concentrically striated or sulcated surface.

Astarte, Sowerby, 1816.

Etym.—*Astarte*, the Syrian Venus.

Syn.—Crassina, Lamarck, 1818. Tridonta, Schum., 1817. Goodallia, Turton, 1822 (part).

Distr.—20 sp. Behring's Straits, Wellington Channel, Kara Sea, Ochotsk, United States, Norway, Britain, Canaries, Ægean; 30–112 fathoms. Fossil, 285 sp. Carb.—; North and South America, Europe, Thibet. *A. semisulcata*, Leach (cxxii, 34). *A. Danmoniensis* (cxxiii, 123).

Shell suborbicular, compressed, thick, smooth or concentrically furrowed; lunule impressed; ligament external; epidermis dark; hinge-teeth 2·2, the anterior tooth of the right valve large and thick; anterior pedal scar distinct; pallial line simple.

Animal with mantle open; margins plain or slightly fringed; siphonal orifices simple; foot moderate, tongue-shaped; lips large, palpi lanceolate; gills nearly equal, united behind, and attached to the siphonal band.

The animal of *Astarte borealis* has mantle-margins free, plain, slightly cirrated in the branchial region; united posteriorly by the branchial septum, forming a single excurrent orifice; pedal muscles distinct from adductors; gills flat, finely striated, destitute of internal partitions; outer gill narrow, elliptical, with a simple margin; inner gill grooved, conducting to the mouth.

ASTARTELLA, Hall and Whitney, 1858. The anterior tooth of the right valve has a longitudinal pit in the summit. *A. vera*, Hall (cxxii, 14, 15). Coal-measures; Illinois and Indiana.

GONILIA, Stol., 1870. Shell orbicular, small, hinge with three distinct cardinal teeth in each valve, surface with angular striæ, no epidermis. *A. bipartita*, Philippi (cxxii, 35). The round, rather Lucinoid form and the angular striation of the surface indicate in this species a distinct section of Astarte, similar to Cyclas, a subgenus of Lucina.

LIRODISCUS, Con., 1869. Shell subquadrangular, concentrically ribbed, posterior side lobed by an impressed line; hinge with two cardinal teeth in each valve, right valve with a small pyramidal anterior lateral tooth, left with a posterior one distant from the cardinals. *Ast. tellinoides*, Con. Eocene.

RICTOCYMA, Dall, 1871. Shell and hinge like Astarte; sculpture consisting of broken, nodulous waves, irregularly concentric, covered with a thick epidermis; equivalve and nearly equilateral. *A. mirabilis*, Dall (cxxii, 36). Alaska.

CRASSINELLA, Bayle. Shell obliquely lengthened, subquadrangular. *A. obliqua*, Desh. Jurassic.

PLIONEMA, Conrad, 1872. Shell subrotund, sculptured, with close radiating lines or fine ribs; hinge of left valve with two robust diverging teeth; lunule none. *A. Guerangeri*, d'Orb.

GOODALLIA (Turton, 1822), Deshayes, 1860.

Syn.—Parastarte, Conrad, 1862. Callicistronia, Dall, 1883.

Distr.—Recent; Europe, U. S. Fossil, 8 sp. Eocene; Paris. *G. miliaris*, Defrance (cxxi, 18).

Shell small, trigonal, equivalve, inequilateral; valves closed; cardinal teeth in the right valve two, diverging, separated by a triangular socket; in the left valve, one triangular, sometimes bifid; lateral wanting, or rudimentary; ligament external, very short; pallial line simple.

GOODALLIOPSIS, Raincourt and Munier, 1863.

Distr.—*G. Orbignyi*, Rainc. and Mun. (cxxi, 19, 20). Eocene: Fercourt.

Shell oval, flattened, equivalve, inequilateral, smooth, slightly dilated in front, and compressed behind; valves closed: hinge with two cardinal teeth, separated by a triangular socket, in each valve; lateral teeth distinct and elongated, one in each valve. Other characters those of Goodallia.

GROTRIANA, Speyer, 1860.

Distr.—Oligocene; Germany. Cretaceous; So. India. *G. semicostata*, Speyer (cxxi, 21, 22).

Shell roundish, moderately compressed, concentrically sulcated or striated, lunula and area very deeply excavated: beaks produced and pointed, hinge with two or more (often three) cardinal teeth in the right and two in the left valve, the middle tooth in the former and the anterior in the latter being the strongest; each valve with a rib-like marginal lateral tooth on either side, accompanied by a groove, muscular impressions oval, moderately excavated, internal margin finely crenated.

This genus greatly resembles in external form an Astarte, but is readily distinguished from it by the presence of the peculiarly elongated lateral teeth and the deep lunula and area. The cardinal teeth equally easily distinguish the genus from Eriphyla, Gabb (Crassatellidæ), in which the pallial line is truncate posteriorly, or more or less distinctly sinuated.

PRÆCONIA, Stoliczka, 1870.

Syn.—Hippopodium, d'Orb. (in part).

Distr.—Oolite—. *P. terminalis*, Romer.

Shell oval, elongated, solid, very inequilateral, beaks subanterior, approached, incurved, surface concentrically lamellated or striated; muscular impressions strong; hinge with two cardinal teeth in the left and three in the right valve, the anterior in the latter being often obsolete, and the posterior are in both elongated; sometimes there appears to be an indication of a posterior lateral tooth. This genus includes a great number of chiefly lower and middle mesozoic species; there are scarcely any known from cretaceous deposits.

ALVEINUS, Conrad, 1865.

Distr.—Tertiary; Miss. *A. minuta*, Conr. (cxxi, 23).

Shell smooth, anterior, posterior and ventral margins channeled within; hinge of right valve emarginated under the apex, and having one pyramidal tooth anteriorly; hinge of the left valve with a pit under the apex, and two diverging teeth anteriorly

LUTETIA, Deshayes, 1860.

Distr.—2 sp. Fossil. Paris Basin. *L. Parisiensis*, Desh. (cxxi, 24).

Shell small, orbicular, globose, equivalve; valves closed; border simple and entire; hinge narrow; cardinal teeth three in each valve, two diverging; the third large and obliquely placed between the others; muscular scars small, oval, submarginal, equal; pallial line simple; ligament external.

MICROMERIS, Conrad, 1866.

Syn.—Pteromeris, Conr., 1865.

Distr.—Eocene; Alabama. *M. minutissima*, Lea (cxxi, 25).

Shell trigonal, with produced, somewhat attenuated, rather straight beaks, ventrally rounded, slightly inflated, striated or sulcated on the surface; the hinge appears to have two small cardinal teeth in the left valve and one in the right, and one long posterior lateral tooth in each.

WOODIA, Deshayes, 1860.

Etym.—Dedicated to Searles V. Wood, a distinguished palæontologist of England. *Syn.*—Digitaria, Wood.

Distr.—1 recent sp. Mediterranean; also fossil in the Tertiary. *W. marginalis*, Desh. (cxxi, 26).

Shell small, rounded, equivalve, equilateral; valves closed, smooth, or ornamented with oblique, curved striæ; hinge thick; right valve with a single, large, median, triangular tooth, depressed or channeled in the middle; left valve with two narrow, unequal, diverging teeth; lateral tooth wanting or rudimentary; ligament internal, small; muscular scars small, equal, oval or ovate; pallial line simple.

ELATHIA, Issel.

Distr.—*E. Arconatii*, Issel (cxxi, 27, 28). Red Sea.

Shell ovately elongated, much compressed, inequilateral, anteriorly much shorter; concentrically striated; umbones very small, curved in; lunule small, deep; hinge with a single, large, elongated cardinal tooth in each valve.

In form it resembles Goodallia, but also exhibits considerable relation to some of the elongated forms of Loripes.

EULOXA, Conrad, 1864.

Distr.—*E. latisulcata*, Conr. (cxxi, 16, 17). Miocene; U. S.

Shell like Astarte, somewhat produced posteriorly, hinge apparently with three cardinal teeth in the left valve, the two teeth on the sides being much smaller than the median one, and two teeth in the right valve.

OPIS, Defrance.

Etym.—*Opis*, a name of Artemis.

Distr.—Fossil, 42 sp. Trias—Chalk; Europe. *O. lunulata*, Miller (cxxi, 38).

Shell strong, ventricose, cordiform, obliquely keeled; beaks prominent, incurved, or subspiral; cardinal teeth 1·1; lunule distinct.

OPISOMA, Stoliczka, 1870. Shell trigonal, much higher than long, with long attenuated slightly incurved and approached beaks, lunule large and deep; hinge with three elongated cardinal teeth in each valve, and a small posterior lateral tooth situated above the posterior muscular impression, which is only slightly larger than the anterior one, both being deeply excavated.

Species referable to this group occur in Upper Jurassic and Cretaceous rocks; in form they perfectly resemble some species of Opis, but the hinge is considerably different, possessing more cardinal teeth than are to be observed in that genus. *O. Geinitziana*, Stol. (cxxii, 38).

PROSOCŒLUS, Keferstein, 1857.

Distr.—3 sp. Devonian; Eur. *P. ovalis*, Keferstein (cxxii, 45, 46).

Shell long oval, thick, smooth, lunule deep; cardinal teeth 2·2, the anterior oblique, the posterior strong and lengthened, nearly parallel with the hinge-margin; no lateral teeth; anterior muscular impression deep, posterior shallow.

PACHYDOMUS, Morris, 1845.

Etym.—*Pachus*, thick; *domos*, house.

Syn.—Megadesmus, Sowb.

Distr.—Fossil, 5 sp. Devonian? New South Wales, Tasmania.

Shell oval, ventricose, very thick; ligament large, external; lunette more or less distinct; hinge-line sunk; teeth one or two(?) in each valve; adductor impressions deep; anterior pedal scar distinct; pallial line broad and simple, or with a very shallow sinus.

NOTOMYA, M'Coy, 1847. (Mæonia, Myonia, Pyramia, Cleobis, Dana.) Shell transversely oval, subequivalve, inequilateral, solid, slightly gaping at both ends; hinge with one strong tooth in the right valve, which appears to correspond to a pit in the left, the two muscular impressions are large and deep, a third, small accessory one is situated above the anterior large one; pallial sinus very small, or only indicated by a truncation of the pallial line; ligament strong, external. Palæozoic; New South Wales. *P. securiformis*, M'Coy (cxxi, 10).

ASTARTILA, Dana, 1849. Shell elongately subtriangular, inequilateral, slightly inflated, moderately thick at the beaks and near

the margins, thin in the middle, on the surface concentrically striated or lamellated; ligament external, very long; muscular impressions rather large, the anterior close to the hinge and with a small superimposed impression; pallial line entire, hinge unknown. *A. intrepida*, Dana (cxxii, 14). Carb.; N. S. Wales. This group is based upon a number of carboniferous species from New South Wales; they greatly resemble in external form the subgenus Caryatis of Cytherea, but the long ligament and muscular impressions appear to be very similar to those of Astarte. The examination of the hinge-teeth is required for the correct determination of the family to which these shells belong.

MECYNODON, Keferstein, 1857.

Distr.—Devon.; Eur. *M. carinatus*, Goldfuss (cxxii, 42, 43).

Shell rather long, thin, concentrically striated or smooth, with a diagonal keel, extending from the beak to the posterior margin; ligament external, short; hinge in either valve with an elevated, long tooth parallel with the hinge-margin, and a pit, posterior to the tooth in the right valve, and anterior to it in the left, in both valves a long and stout posterior lateral tooth; anterior muscular impression deep, with a smaller but deeper impression of the foot-retractor behind it; posterior impression near the middle of the posterior margin.

SUBFAMILY *CARDITINÆ.*

Shells roundly ovate or transversely elongated, always provided with radiating ribs or striæ.

CARDITA, Bruguière, 1789.

Etym.—*Cardia*, the heart.

Syn.—Arcinella, Oken. Pseudocardia, Vetocardia, Conrad. Actinobolus, Klein, 1753.

Distr.—50 sp. Universal. Fossil, 5 sp. Lower Silurian—Trias; United States, Europe, New South Wales, Tasmania. *C. sulcata*, Lam. (cxxiii, 67). *C. antiquata*, Linn. (cxxiii, 68).

Shell oblong, radiately ribbed; ligament external; margins toothed; hinge-teeth 1·2, and an elongated posterior tooth; pallial line simple; anterior pedal scar close to adductor.

Animal with the mantle-lobes free, except between the siphonal orifices; branchial margin with conspicuous cirri; foot rounded and grooved, spinning a byssus; labial palpi short, triangular, plaited; gills rounded in front, tapering behind, and united together, the outer pair narrowest.

REDONIA, Rouault. Shell oval, tumid; hinge with cardinal and posterior teeth; anterior adductor bounded by a ridge. Fossil. Lower Silurian; Brittany, Portugal. *C. Deshayesiana*, Rouault (cxxii, 47, 48).

MILNERIA, Dall, 1881.

Etym.—In honor of the late Dr. J. W. Milner, of the U. S. Fish Commission. *Syn.*—Ceropsis, Dall, 1871.

Distr.—*M. minima*, Dall. Nestling in Haliotis, California.

Shell small, ribbed or sculptured; with a Λ-shaped cardinal tooth in the right valve; left valve with a stout anterior and slender posterior cardinal tooth, diverging, and a very slight groove in the posterior margin; no lateral teeth in either valve, and no groove in the right valve; umbones almost posterior, general form trapezoidal.

MYTILICARDIA, Blainv., 1824.

Distr.—24 sp. Universal. *M. variegata*, Brug. (cxxiii, 69).

Shell elongated, very inequilateral, with squamous radiating ribs; hinge with an anterior triangular cardinal tooth; posterior cardinal tooth double in the left valve; no anterior laterals.

Foot rounded, grooved, byssiferous.

AZARELLA, Gray, 1852. (Beguina, Bolten, 1798.) Shell compressed, margins rounded, striated; hinge elongated, submarginal, without lateral teeth. *M. semiorbiculata*, Linn. (cxxiii, 70, 71).

GLANS, Muhlfeldt, 1811. Shell trapezoidal, with radiating ribs. *M. trapezia*, Brug.

THECALIA, H. and A. Adams, 1855. Shell oblong, radiately ribbed; interiorly with a remarkable cup-like inflection of the ventral margin of each valve, resembling the cup of a Calyptræa. *M. concamerata*, Chemn. (cxxii, 49).

PALÆOCARDITA, Con., 1867. Shell elongately trapezoid, inequilateral, moderately inflated, radiately ribbed; hinge with two blunt cardinal teeth and one posterior lateral tooth in each valve. Conrad proposed this group for the Triassic *Cardium austriacum*, Hauer, but the better known Cassian *Cardita crenata*, Münst. (cxxii, 50, 51), may rather be considered as the type. These cretaceous Mytilicardiæ mostly differ from the recent species by the want of an anterior insinuation of the ventral margin, where in true Mytilicardiæ there should be a small gape; the posterior cardinal is also less elongated in the fossil forms.

CARDITAMERA, Conrad, 1838.

Syn.—Lazaria, Gray, 1853.

Distr.—6 sp. W. Coast N. America, W. Indies, Madagascar. Fossil. Miocene; U. S. *C. pectunculus*, Brug. (cxxiii, 72).

Shell transverse, oblong, inequilateral, beaks subanterior, radiately ribbed; hinge with two cardinal and two lateral diverging teeth in each valve, the posterior teeth being in each case much elongated, the anterior short and more or less pointed, sublunular.

VENERICARDIA, Lam., 1801.

Syn.—Cardiocardita, Blainv.

Distr.—*V. planicostata*, Lam. (cxxiii, 73). Fossil; Cret., Tert.

Shell suborbicular, inequilateral, radiately ribbed; hinge with two oblique cardinal teeth, and no laterals.

Animal locomotive, with a sickle-shaped foot, like Cardium.

CYCLOCARDIA, Con., 1867. Rounded, radiately costate, covered with a rough epidermis; hinge with two robust teeth in the left valve, directed obliquely backwards, the posterior one elongated and slightly curved; anterior tooth of the right valve rudimentary. *V. borealis*, Con. (cxxiii, 74). 3 sp. U. S.

PLEUROMERIS, Conrad, 1867. Shell subtriangular, radiately ribbed, hinge in the right valve with one broad, furrowed, recurved tooth, in the left valve with three teeth, the anterior one small and fitting into a cavity in the opposite valve. *V. tridentata*, Say (cxxii, 60).

MIODON, Carpenter, 1864.

Distr.—*M. prolongatus*, Carp. West Coast U. S. *M. orbicularis*, Sowb. (cxxii, 52–54). Oolite; England.

Shell ovately subtrigonal, small, solid, ventrally much produced, with the umbones situated anteriorly, radiately ribbed, the ribs being partially intersected by concentric sulcations; hinge in the right valve with one posterior cardinal and one anterior lateral tooth, left valve with one triangular anterior and one elongated posterior cardinal, and a very small anterior lateral tooth. Closely allied to Pleuromeris.

PROROKIA, Boehm, 1883.

Distr.—Fossil, 4 sp. *P.* (*Cardita*) *ovalis*, Quenst.

Shell small, long-ovate, equivalve, very inequilateral, beaks slightly curved, anterior; surface concentrically striate; inner margin thickened and crenulated; teeth 1·2, with a slightly developed posterior lateral and a still smaller anterior lateral; anterior impression linear, deep, surrounded by a peculiar swelling, posterior impression on a raised plate.

CARDITELLA, E. A. Smith, 1881.

Distr.—3 sp. S. Am. *C. pallida*, Smith.

Shell exteriorly like Cardita; hinge composed of two cardinal teeth in the left valve and one in the other; each valve has also two lateral teeth, one nearly marginal on the one side, the other on the opposite side being well within the outer edge, with a groove between it and the margin for the reception of the submarginal tooth of the other valve; external ligament small, yet distinct; internal cartilage minute, placed immediately beneath the apex of the valves; pallial line simple.

Carditopsis, E. A. Smith, 1881.

Distr.—*C. flabellum*, Reeve.

Shell without external ligament; cardinal teeth one on one side of the cartilage-pit, and two united above on the other side; lateral teeth more delicate than in Carditella, internal ligament considerably larger.

Pleurophorus, King, 1848.

Syn.—Unionites, Wissm.

Distr.—*P. costatus*, Brown (cxxi, 6). Permian; England.

Shell oblong; dorsal area defined by a line, or keel; umbones anterior, depressed; hinge-teeth 2·2; laterals 1·1, elongated, posterior; anterior adductor impression deep, with a small pedal scar close to it, and bounded posteriorly by a strong rib from the hinge; pallial line simple.

Matheria, Billings, 1858.

Etym.—Dedicated to Mr. Mather, of the Geological Survey of New York.

Distr.—*M. tenera*, Billings (cxxii, 57–59). Trenton limestone; Canada.

Shell transverse, equivalve; beaks near the anterior end; two small obtuse cardinal teeth in the left valve, and one in the right; ligament external.

Septocardia, Hall and Whitfield.

Distr.—*S. typica.* Jurassic; Nevada. *S. rara*, Meek (cxxii, 55, 56 .

Shell inequilateral, cordiform; hinge strong; right valve with a strong, recurving, hooked tooth under the beak, and a deep cavity below and exterior to it, which is profoundly excavated in the thickened substance of the shell; in the left valve a large deep cavity corresponds to the tooth of the right valve; lateral teeth obsolete; ligament external, situated in a groove formed by a thickened, overlapping portion of the shell posterior to the tooth and corresponding cavity; anterior adductor muscular scar very large and deep, separated from the general cavity of the shell by a calcareous plate, or septum, extending across the anterior end of the valve on the inner side of the scar, thereby forming a distinct chamber in each valve; posterior adductor scar much smaller, situated within the posterior cardinal margin; pedal scars not observed; surface of the shell marked in the typical species by strong, elevated, radiating ribs, with ornamented surfaces similar to many of the recent species of Cardium.

Anodontopsis, M'Coy, 1851.

Distr.—Silur.; Eng., U. S. Type, *A. angustifrons*, M'Coy.

Shell rather compressed, subtrigonal or trapezoid, anteriorly generally somewhat narrowly rounded, posteriorly obliquely truncate, hinge rectilinear, shorter than the length of the shell, with an internal posterior marginal tooth, double in the right valve, and a second shorter one in front of the beaks; a small cardinal tooth is said to be occasionally present below the beaks; muscular scars ovate, the posterior larger and stronger than the anterior; pallial line entire.

Stoliczka considers Microdon, Conrad (p. 191), identical with Anodontopsis.

PSEUDAXINUS, Salter. Shell thin, edentulous, convex, with prominent umbones, and a strong posterior carinated edge; beaks anterior; no lunette. *A. securiformis*, M'Coy, and allied forms.

ORTHODONTISCUS, Meek, 1873. Right valve with a well-defined cardinal tooth, left valve with a corresponding fosset and a rudimentary tooth in front of it; lateral teeth double in the right valve, single in the left. *A. Milleri*, Meek. Silur.; Ohio.

PACHYCARDIA, Hauer, 1857.

Distr.—*P. rugosa*, Hauer. Alpine Trias.

Shell long-oval, nearly trigonal, very inequilateral, concentrically striated or smooth; beaks prominent, approaching, nearly terminal; anterior side strongly swollen, with lunule; posterior side somewhat compressed; margins smooth, the ventral convex in outline; ligament external, short; teeth two in each valve, strong, diverging, the anterior in the right valve less developed and nearly marginal; a long, posterior, lateral tooth in each valve; muscular impressions small, the anterior deep.

ORDER ASIPHONIDA.

Mantle-margins open; no siphons; pallial impression without sinus.

Suborder HOMOMYARIA. Mantle-margins open or closed behind; both muscular impressions equally distinct.

Suborder HETEROMYARIA. Frequently inequivalve; anterior muscular impression very small, posterior impression large.

Suborder MONOMYARIA. Having a single posterior or subcentral adductor-muscle and impression.

SUBORDER *HOMOMYARIA*.

(*Cardiniacea.*)

FAMILY CARDINIIDÆ.

Shell obliquely lengthened or oval, smooth or concentrically striated; ligament external, moderately long; cardinal teeth

usually but slightly prominent, sometimes obsolete; lateral teeth more or less developed, often very thick; muscular impressions simple, deep. (Entirely fossil.)

CARBONICOLA, M'Coy, 1855.

Distr.—20 sp. Carboniferous; Europe, United States. *C. acuta*, Sowb. (cxxiv, 97).

Shell elongated, solid, with moderately tumescent, not eroded, beaks, somewhat impressed in front of them; ligament strong, external; surface concentrically striated; hinge with one very thick cardinal tooth in the right valve, extending posteriorly, with one long anterior and one long posterior lateral tooth; muscular scars one either side, each surmounted by a small accessory impression.

ANTHRACOSIA, King, 1856.

Etym.—*Anthrax*, carbon, in allusion to the carboniferous deposits in which the genus is usually found.

Distr.—61 sp. Devonian—Carboniferous; Westphalia, Saxony, Russia, Belgium, Great Britain, N. America. *A. Lottneri*, Ludwig (cxxv, 10).

Shell equivalve, inequilateral. Teeth one in each valve below the umbone, rather low and massive; crown of tooth of right valve excavated anteriorly and ridged posteriorly; crown of tooth of left valve ridged anteriorly and sloped posteriorly. Umbonal ligamental fulcra each a furrow excavated in the hinge-plate, between the umbone and tooth; scars of the anterior set of pedal muscles, situated above the anterior adductor muscular impressions.

Anthracosia differs from Unio, to which genus the majority of the Unioniform shells have been referred, in its simpler dental system and in the absence of supplementary pedal muscles.

ANOPLOPHORA, Sandberger, 1862.

Syn.—Unionites, Munst. Myacites, Auct.

Distr.—Triassic. *A. lettica*, Quenst. (cxxii, 37).

Shell elongated, laterally moderately compressed, inequilateral, beaks subanterior, hinge with a small indentation, without any perceptible cardinal teeth and with very slightly thickened lateral margins on either side; anterior muscular impression cordiform, enlarged, posterior very faint, ligament linear, external.

Most of the species referable to this genus occur in the Trias; they differ from Cardinia by the want of hinge-teeth, and some forms closely resemble Pleurophorus, but they appear to have a thinner shell.

TRIGONODUS, Sandberger, 1864.

Distr.—*T. Sandbergeri*, Alberti (cxxi, 29, 30). Triassic.

Shell like Cardinia, hinge also nearly the same, except that the posterior lateral tooth is very strong, single in the right and double in the left valve; anterior lateral tooth short and small; cardinal teeth distinct; muscular impressions elongated and attenuated above. Closely allied to Cardinia.

CARDINIA, Agassiz, 1841.

Etym.—*Cardo-inis*, a hinge.

Syn.—Thalassides, Berger, 1833 (no description). Sinemuria, Christol. Pachyodon, Stutch. Ginorga and Dihora, Gray. Storthodon, Brown.

Distr.—Fossil, 71 sp. Silurian—Inferior Oolite; Europe, along with marine shells. *C. Listeri*, Sowb. (cxxi, 31).

Shell trigonal or ovately elongated, compressed, inequilateral, with pointed, not very prominent beaks, these being close together; hinge with one cardinal tooth in the right valve and two small ones in the left, and one remote lateral tooth on either side in each valve; muscular impressions deep, rather small, and situated next to the lateral teeth; ligament of moderate strength, but long.

This genus is sparingly (and rather doubtfully) represented in Silurian rocks; its maximum of development falls in the Lias, and it disappears with the close of the Jurassic period.

(*Naiades.*)

FAMILY UNIONIDÆ.

Shell usually regular, equivalve, closed; structure nacreous, with a very thin prismatic-cellular layer beneath the epidermis; epidermis thick and dark; ligament external, large and prominent; margins even; anterior hinge-teeth thick and striated, posterior laminar, sometimes wanting; adductor scars deeply impressed; pedal scars three, distinct, two behind the anterior adductor, one in front of the posterior.

Animal with the mantle-margins united between the siphonal orifices, and, rarely, in front of the branchial opening; anal orifice plain, branchial fringed; foot very large, tongue-shaped, compressed, byssiferous in the fry, and sometimes in the adult; gills elongated, subequal, united posteriorly to each other and to the mantle, but not to the body; palpi moderate, laterally attached, striated inside; lips plain. Sexes distinct.

The river-mussels are found in the ponds and streams of all parts of the world. In the old world the species are comparatively

few, though specimens are abundant; in North America both species and individuals abound.

Like other fresh-water shells, the Naiades are often extensively eroded by the carbonic acid dissolved in the water they inhabit. This condition of the umbones is conspicuous in the great fossil Uniones of the Wealden, but cannot be detected in the Cardiniæ, and some other fossils formerly referred to this family.

The outer gills of the female Unio are filled with spawn in the winter and early spring; the fry spins a delicate, raveled byssus, and flaps its triangular valves with the posterior shell-muscle, which is largely developed, whilst the other is yet inconspicuous. The shells of the female river-mussels are rather shorter and more ventricose than those of the males.

Over 1200 recent species of Unionidæ are known to science and more than half of these are inhabitants of the rivers of the United States. A large proportion of the species was first described by Dr. Isaac Lea of Philadelphia, who has devoted over fifty years to the study of this family. His "Observations on the genus Unio, with descriptions of new species," etc., now comprises thirteen quarto volumes, illustrated by hundreds of beautiful plates.

UNIO, Retz.

Etym.—*Unio*, a pearl (Pliny). River-mussel.

Syn.—Uniomeris, Conr. (Eocene).

Distr.—1000 sp., universal. Fossil. Cretaceous, Eocene—; Europe. Triassic—; N. Amer. *U. littoralis*, Linn. (cxxiii, 86).

Shell oval or elongated, smooth, corrugated, or spiny, becoming very solid with age; anterior teeth 1·2, or 2·2, short, irregular; posterior teeth 1·2, elongated, laminar.

Animal with the mantle-margins only united between the siphonal openings; palpi long, pointed, laterally attached.

The subgenera are mainly founded upon peculiarities of form and ornamentation or sculpture; they are of no value except as conveniences for classifying the species; and Dr. Isaac Lea, the great authority upon this family, has discarded them altogether and used instead, in his admirable "Synopsis of Unionidæ," a division into sections by the form of the shell, and these into subsections by the sculpture.

I annex the so-called subgenera, as adopted by H. and A. Adams, Chenu and others.

BARIOSTA, Rafinesque, 1831. (Potamida, Swainson, 1840.) Shell arcuated, smooth. *U. emarginatus*, Lea (cxxiii, 75).

NAIDEA, Swainson, 1840. Shell obovate or mytiliform, smooth. *U. Modioliformis*, Lea (cxxiii, 76).

NAIA, Swainson, 1840. Shell oblong, smooth. *U. depressus*, Lam. (cxxiii, 77).

HYRIDELLA, Swains., 1840. (Micromya, Agassiz, 1852.) Shell oval, smooth. *U. batavus*, Lam. (cxxiii, 78).

OBOVARIA, Rafinesque. Shell subrotund, smooth. *U. retusus*, Lam. (cxxiii, 79, 80).

LAMPSILIS, Rafinesque, 1820. (Pleurobema, Plagiola, Scalenaria, Syntoxia and Truncilla, Rafinesque. Æglia, Swains., 1840.) Shell more or less triangular or oblique, truncated posteriorly, smooth. *U. elegans*, Lea (cxxiii, 81).

CANTHYRIA, Swainson, 1840. Shell subtrigonal, spinose. *U. spinosus*, Lea (cxxiii, 82).

IRIDEA, Swainson, 1840. Shell oval or wide, nodulous. *U. cylindricus*, Say (cxxiii, 83). *U. perplexus*, Lea.

ROTUNDARIA, Rafinesque, 1830. Shell obliquely rounded, nodulous. *U. pustulosus*, Lea.

QUADRULA, Rafinesque, 1820. (Theliderma, Swainson, 1840.) Shell subquadrangular, tuberculated. *U. apiculatus*, Say.

DIPLODON, Spix, 1827. Shell oval, oblong or wide, plicate. *U. pliciferus*, Lea. *U. Grayanus*, Lea.

DYSNOMIA, Agassiz, 1851. Shell triangular or quadrangular, plicate. *U. plicatus*, Lesueur (cxxiii, 84).

METAPTERA, Rafinesque, 1820. Shell with a wing-like postero-dorsal prolongation of the valves, by which they become connate or soldered together. *U. alatus*, Say (cxxiii, 85). *U. delphinus*, Gruner.

UNIOCARDIUM, Capellini. Obliquely lengthened, very inequilateral, the margin produced below, with a posterior sharp rib or angle. Fossil. Congarienschichten, Sterza.

UNIONA, Pohlig, 1880. Shell thick, somewhat inequivalve, with a lunule; apex eroded; hinge with two three-cornered teeth in the right valve and one in the left valve, right valve with one short lateral tooth, left with two; near the anterior muscular impression are two accessory impressions. 2 sp. Triassic; Germany. *U. maritima*, Pohlig.

LOXOPLEURUS, Meek, 1876. Elongate-subovate, somewhat arcuate, without wings, ornamented with two sets of very regular, well-defined costæ, those of one of which start from the margin just in front of the beaks, and radiate obliquely backward and downward; while those of the other set start from the dorsal margin behind the beaks, and extend downward in a direction that would cause them to intersect those of the other series at rather acute angles along the posterior umbonal slopes somewhat as in Goniomya. *U. belliplicatus*, M. Fossil. Wyoming, near junction of Cret. and Lower Tertiary.

The following arrangement by Dr. Lea is based upon the same characters as the above "subgenera," but is a more comprehensive scheme, providing pretty well for the natural grouping of all the species.

Genus Margaron, Lea.
Subgenus Unio, Retzius.

Symphynote—
 Plicate.
 Smooth. Triangular, oval, oblong.
Non-Symphynote—
 Plicate. Quadrate, triangular, oval, oblong, subrotund, wide, arcuate.
 Nodulous. (Subdivided as above under "Plicate.")
 Spinous. Triangular.
 Sulcate. Triangular, oval, oblong, subrotund.
 Smooth. Triangular, oblique, oval, oblong, subrotund, wide, obovate, arcuate.

MARGARITANA, Schumacher, 1817.

Syn.—Baphia, Meuschen, 1787.

Distr.—40 sp. N. America, Europe. Fossil. Cret.—; N. Am.

Shell like Unio, but without lateral teeth.

There is so little difference between this genus and Unio, that for systematic purposes it would be better placed as a subgenus of the latter: the universal custom of using its generic name in connection with the species prevents such disposition of it. Dr. Lea applies to the classification of this genus the same admirable scheme which he has used for the Uniones. H. and A. Adams restrict the typical group to those species having smooth, oblong, transverse shells, and then admit the three following subgenera, which might better be suppressed, and their names added to the generic synonymy. *M. margaritifera*, L. (cxxiv, 88, 89), the species which afforded the once-famous British pearls, is circumboreal in distribution, occurring in Europe, Siberia, British America and the Northern United States. It is a remarkable exception to the rule of limited distribution of the species of the family.

ALASMODONTA, Say, 1820. Shell subtrigonal, inflated, beaks prominent, surface smooth. *M. Curreyana*, Lea.

COMPLANARIA, Swains., 1840. Valves connate, surface plicate. *M. confragosa*, Say.

UNIOPSIS, Swainson, 1840. (Calceola, Swainson, 1840.) Shell ovate; surface of valves smooth; cardinal teeth two, irregular or receding from the anterior margin, or with tubercles and undulations representing cardinal teeth. *M. calceola*, Lea.

MONOCONDYLÆA, d'Orb., 1835.

Distr.—30 sp. South America, Southern Asia. *M. Guarayana*, d'Orb. (cxxiv, 90).

Shell externally like Unio, internally the hinge, like Margaritana possesses cardinal but not lateral teeth; the cardinals are peculiar

in being single in each valve, and tubercular, not entering a pit in the opposite valve, that of the right valve being posterior to the left. The typical group comprises South American species; the following subgenera, proposed for Asiatic species, have very slight distinctive characters.

PSEUDODON, Gould, 1844. The hinge-tooth of the right valve fits into an emargination situated in front of the beak of the left valve, while the tooth itself of this latter valve is below the beak. *M. Peguensis*, Anthony. Burmah.

TRIGONODON, Conrad, 1865. The hinge-tooth of the right valve erect, almost vertically or obliquely elongated, fitting into a divided tooth of the left valve, the posterior portion of the left tooth being much larger than the anterior. *M. crebristriata*, Anthony. Pegu.

LEGUMINAIA, Conrad, 1865. Outline approaching *Margaritana margaritifera*, being medially contracted and of an oblong and leguminous shape. The cardinal tooth is pyramidal and recurved, wholly unlike the transverse compressed tooth of Pseudodon. *M. Mardinensis*, Lea. River Tigris.

Dr. Stoliczka, commenting upon the above groups, concludes thus:

"Large series of all these shells in different stages of growth should be examined, for there is no doubt that they gradually pass one into the other, and connect Margaritana with Unio. Certainly nothing can be more unnatural than creating new generic groups upon the examination of single shells, particularly among such most variable forms as the fresh-water Unionidæ are known to be, and then attempting to assimilate the various species to the imaginary characteristics. It is just the contrary way, we have to take in a natural classification."

MICROCONDYLÆA, Vest. Gills united to the mantle in their entire length, a small cardinal tubercle in each valve. *Margaritana Bonelli*, Fer. Europe.

PLAGIODON, Lea, 1856.

Distr.—*P. Isocardioides*, Lea (cxxiv, 91). Rio Plata.

Shell inequivalve, ventricose, obliquely trigonal; cardinal teeth transverse, crenulated, compressed, double in each valve; no lateral teeth.

DIPSAS, Leach, 1814.

Syn.—Barbala, Humphrey, 1797. Dianisotis, Raf., 1831. Symphynota, Swains., 1840.

Distr.—2 sp. China. *D. plicatus*, Leach (cxxiv, 92).

Shell usually alate or winged postero-dorsally; hinge with a single long linear tooth on the dorsal margin.

ANODONTA, Cuvier.

Etym.—*Anodontos*, edentulous. Swan-mussel.

Syn.—Limnæoderma, Poli, 1835. Hemiodon, Swains., 1840.

Distr.—200 sp. World-wide. Fossil. Laramie Gr.—; N. Am. *A. cygnea*, Linn. (cxxiv, 96).

Shell like Unio externally, usually much thinner and smooth; hinge without teeth.

Dr. Lea divides the species as he does Unio.

The following subgeneric groups are without much value:

LAMPROSCAPHA, Swainson, 1840. Shell transversely elongated, narrow; beaks subanterior. *A. ensiformis*, Spix.

PATULARIA, Swainson, 1840. (Glabaris, Gray.) Shell cordiform or rounded. *A. latomarginata*, Lea (cxxiv, 94).

GONIDEA, Conrad, 1857. Shell wedge-shaped, posterior slope defined by a high angle; a rudimentary cardinal tooth in the right valve fits into a depression in the left valve. *A. angulata*, Lea (cxxiv, 95).

? AMNIGENIA, Hall, 1883. Like Anodonta in form and external characters; probably fresh-water or estuary. *A. Catskillensis*, Vanuxem. Fossil; Oneonta sandstone, N. Y.

FAMILY IRIDINIDÆ.

Shell externally like Unio; hinge-line usually crenated, making numerous transverse teeth, or with lamellar teeth more or less crenated.

Mouth and lips small, labial palps very large, oval, attached by their straight edges, without any free points as in Unionidæ. Mantle-lobes united posteriorly, and prolonged into two short, unequal siphonal tubes; gills large, nearly equal, united to the body. Foot large, thick, compressed, tongue-shaped, angular in front.

IRIDINA, Lamarck, 1819.

Etym.—*Iris*, the rainbow.

Syn.—Mutela, Scop., 1777. Platiris, Lea.

Distr.—9 sp. Rivers of Africa, Nile, Senegal. *I. exotica*, Lam. (cxxiv, 99).

Shell oblong; umbones depressed; hinge-line long, straight, attenuated towards the umbones, crenated by numerous unequal teeth; ligament long and narrow.

Animal with mantle-lobes united posteriorly, forming two short siphons; mouth and lips small; palpi immense, oval; gills united to the body.

CALLISCAPHA, Swains., 1840. Hinge crenated near the umbones only. *I. Nilotica*, Lam.

PLEIODON, Conrad, 1835. Cardinal margin wide, profoundly crenulated. *I. ovata*, Swainson (cxxiv, 100).

SPATHA, Lea, 1838. Shell oval, thick; cardinal margin arcuated and nearly smooth. Outer gill united to the mantle as far as its extremity; inner gill not united to the foot. *S. rubens*, Lea (cxxiv, 8). E. Africa.

LEILA, Gray, 1842. (Columba, Lea.) Shell oval, inflated, very inequilateral, gaping, with prominent beaks; cardinal margin straight, simple. *L. Blainvilleana*, Lea (cxxiv, 5). So. America.

? HAPLOTHŒRUS, Conrad, 1874. Equivalve; hinge-margin straight, cartilage-area very broad and thick, hinge edentulous; anterior muscular scar small, narrow, and deeply impressed, accessory situated under the primary scar. *H. capax*, Conr. (cxxv, 8, 9). Fossil; Pebas Group, Upper Amazon. Described from fragments; the portion containing the posterior muscular impression is missing.

TRIQUETRA, Klein, 1753.

Syn.—Hyria, Lam., 1819. Pachyodon, Schumacher, 1817. Triplodon, Spix, 1827.

Distr.—4 sp. South America. *T. avicularis*, Lam. (cxxiv, 2). *T. corrugata*, Lam. (cxxiv, 1).

Shell Arca-shaped, hinge-line straight, with a dorsal wing on the posterior side; hinge with cardinal and lateral teeth, the latter serrated. Mantle-lobes united together behind and furnished with two short, contractile siphons.

PRISODON, Schum., 1817.

Syn.—Tetraplodon, Spix, 1827. Castalia, Lamarck, 1819.

Distr.—3 sp. Rivers of South America, Guiana, Brazil. *P. ambigua*, Lam. (cxxiv, 3, 4).

Shell ventricose, trigonal; umbones prominent, furrowed; hinge-teeth striated; anterior 2·1, short; posterior 1·2, elongated.

Animal with mantle-lobes united behind, forming two distinct siphonal orifices, the branchial cirrated; outer gill united to the mantle as far as its extremity; buccal appendages rounded, very large; foot much compressed, thicker and bent behind.

ARCONAIA, Conrad, 1865.

Distr.—*A.* (*Triquetra*) *contorta*, Lea (cxxv, 16, 17). China.

Shell elongated, bent or bow-shaped; hinge with two distant, oblique, robust, short cardinal teeth, finely rugose-striate; lateral teeth elongated, minutely rugose-striate (not serrated).

FAMILY MYCETOPODIDÆ.

Shell thin, soleniform, transversely elongated, gaping at both extremities; hinge-line straight, linear, without teeth.

Animal with greatly developed foot, ending in a disk-like expansion.

MYCETOPUS, d'Orbigny, 1835.

Etym.—Mukes, a mushroom; *pous*, the foot.

Distr.—3 sp. River Parana, Corrientes; River Amazon, Bolivia. *M. soleniformis*, Orb. (cxxv, 11).

Shell elongated, subcylindrical, gaping in front; margins subparallel, hinge edentulous.

Animal with an elongated, cylindrical foot, expanded into a disk at the end; mantle open; gills equal; palpi short.

SOLENAIA, Conrad. Elongated, thin, gaping anteriorly, hinge with a long, acicular lateral tooth in each valve, slightly developed. Recent; Oriental. *M. emarginatus*, Lea (cxxv, 12, 13).

(*Ætheriacea.*)

FAMILY ÆTHERIIDÆ.

Shell irregular, inequivalve, attached, pearly within. Animal without foot. These may be likened to oysters, which they much resemble in the general appearance of the shell. The family includes three somewhat similar genera, one of which is African, the others South American.

ÆTHERIA, Lamarck, 1808.

Etym.—Aitherios, aërial. Fresh-water oyster.

Distr.—4 sp. River Nile, from first cataracts to Fazool; River Senegal. *Æ. Cailliaudi*, Fer. (cxxiv, 6).

Shell irregular, inequivalve; attached by the umbo and tubular processes of one of the valves, usually the left; epidermis thick, olive; interior pearly, blistered (as if with air-bubbles); hinge edentulous; ligament external, with a conspicuous area and groove in the fixed valve; two adductor impressions, the anterior very long and irregular; pallial line simple.

Animal with the mantle-lobes open; body large, oblong, projecting backwards; no trace of a foot; palpi large, semioval; gills subequal, plaited, united posteriorly, and to the body and mantle.

MULLERIA, Férussac, 1823.

Etym.—Dedicated to Otto Frid. Müller, author of the "Zoologia Danica." *Syn.*—Acostæa, d'Orbigny, 1851.

Distr.—River Magdalena, near Bogota, New Grenada. *M. Guaduasiana*, Orb. (cxxv, 14, 15).

Shell, when young, free, equivalve, Anodon-shaped, with a long and prominent ligament, and two adductor impressions; adult irregular, inequivalve, attached by the right valve; umbones elongated, progressively filled up with shell, and forming an irregular "talon" in front of the fixed valve; epidermis thick; ligament in a marginal groove; interior pearly, muscular impressions single, posterior.

BARTLETTIA, H. Adams, 1866.

Distr.—*B. Stefanensis*, Moric. cxxiv, 7). Amazon River.

Shell free, equivalve, closed, inequilateral, the anterior portion being peculiarly produced and rugose, the ventral edge insinuated, hinge edentulous; ligament marginal, partially internal, supported by strong fulcra, muscular scars two, marginal; pallial line entire.

This singular shell has the irregular growth of the attached genera, except that it is equivalve; in possessing two muscular scars it is nearest allied to Ætheria.

(*Trigoniacea.*)

FAMILY TRIGONIIDÆ.

Shell equivalve, close, trigonal, with the umbones directed posteriorly; ligament external; interior nacreous; hinge-teeth few, diverging; pallial line simple.

Animal with the mantle open; foot long and bent; gills two on each side, recumbent; palpi simple.

TRIGONIA, Bruguière.

Etym.—*Trigonos*, three-angled.

Syn.—Lyriodon, G. Sowerby. Myophorella, Bayle.

Distr.—3 sp. (or varieties?). Australia. Fossil, 100 sp. Devonian—; Europe, United States, Chili, Algeria, Cape, South India. *T. pectinata*, Lam. (cxxv, 18).

Shell thick, tuberculated, or ornamented with radiating or concentric ribs; posterior side angular; ligament small and prominent; hinge-teeth 2·3, diverging, transversely striated; centre tooth of left valve divided; pedal impressions in front of the posterior adductor, and one in the umbo of the left valve; anterior adductor impression close to the umbo.

Animal with a long and pointed foot, bent sharply, heel prominent, sole bordered by two crenulated ridges; palpi small and pointed; gills ample, the outer smallest, united behind the body to each other and to the mantle.

The shell of Trigonia is almost entirely nacreous, and usually wanting or metamorphic in limestone strata; casts of the interior are called "horse-heads" by the Portland (England) quarrymen; they spoil the stone. Silicified casts have been found at Tisbury, in which the animal itself, with its gills, was preserved. The species with the posterior angle of the shell elongated have a siphonal ridge inside. The epidermal layer of the recent shell consists of nucleated cells, forming a beautiful microscopic object. A Trigonia placed by Mr. S. Stutchbury on the gunwale of his boat leapt overboard, clearing a ledge of four inches; they

are supposed to be migratory, as dredging for them is very uncertain, though they abound in some parts of Sydney Harbor.

Trigoniæ appeared in Devonian and Liassic strata, became numerous in the Jurassic and Cretaceous, and have since continued to decline. Australia, where so many others of earth's oldest forms continue to exist, furnishes the only living species.

Trigoniæ are divided according to form and sculpture into several sections, all of which are extinct except the last.

Scaphoidea. *T. navis*, Lam. (cxxv, 19). Lias; Alsace.

Undulatæ. *T. undulata*, Fromh. Jura.

Costatæ. *T. costata*, Lam. (cxxv, 20). Oolite; Switzerland.

Glabræ. *T. longa*, Agassiz (cxxv, 21). Neocomian; Neufchatel.

Quadratæ. *T. Parkinsonii*, Agassiz (cxxv, 22). Portlandian; Besançon.

Scabræ. *T. scabra*, Lam. (cxxv, 23). Cretaceous.

Byssiferæ. *T. carinata*, Agass. Neocomian.

Clavellatæ. (Myophorella, Bayle.) *T. clavellata*, Sowb. Jura.

Pectinatæ. *T. pectinata*, Lam. Australia (living).

Schizodus, King, 1848.

Syn.—Axinopsis, Tate. Megalodus (part), Goldf.

Distr.—Fossil, 20 sp. Upper Silurian—Muschelkalk; United States, Europe. *S. Schlotheimi*, Geinitz (cxxvii, 56).

Shell trigonal, rounded in front, attenuated behind; rather thin, smooth, with an obscure, oblique ridge; ligament external; hinge-teeth 2·3, smooth, rather small; anterior adductor slightly impressed, removed from the hinge, with a pedal scar close to it; pallial line simple.

NEOSCHIZODUS, Giebel, 1856. Shell similar to Schizodus; hinge of the left valve with a large posterior, subterminal, cardinal tooth, posteriorly prolonged, parallel to the fulcra, which are distinct from the margin itself, and with an anterior terminal cardinal; right valve with a marginal elongated posterior and a subterminal shorter, but thicker, anterior cardinal tooth. *S. lævigatus*, Giebel. Triassic; Germany.

MYOPHORIA, Bronn, 1830. (Cryptina, Boue.) Shell trigonal, umbones turned forwards; obliquely keeled; smooth or sculptured; teeth 2·3, striated obscurely, centre tooth of left valve simple, anterior of right valve prominent; mould like Trigonia. *M. decussata*, Munst. (cxxvii, 57), has a lateral tooth at the dorsal angle of the left valve. Fossil, 16 sp. Trias; Germany, Tyrol.

PRISCONAIA, Conrad, 1867. Shell ovate; hinge in the left valve with two cardinal teeth, the anterior compressed, angular, oblique, with an anterior pit; the posterior broad, smooth, convex, triangular, situated under the beak and directed posteriorly, emarginated at its end; no lateral teeth; muscular impression

situated near the cardinal line. Type, *P. ventricosa*, Con. (cxxiv, 98). Carboniferous; Kansas. This genus, Conrad says, bears the same relation to Carbonicola that Margaritana bears to Unio. Mr. Meek says, "I differ from Mr. Conrad in regard to the relations of Prisconaia; I think it belongs to the Trigoniidæ, near Schizodus—if not the same."

REMONDIA, Gabb, 1869.

Distr.—*R. furcata*, Gabb (cxxvii, 58, 59). Cretaceous; Mexico. *R. Bronnii*, Krauss. Cretaceous; So. Africa.

Shell compressed, elongately subquadrate, inequilateral, the beaks being subanterior; ligament very short, external; hinge composed of three moderately diverging, elongated cardinal teeth and one long posterior lateral in the left valve; those of the right would appear to be similar and corresponding to those of the left. The middle cardinal of the left valve is transversely striated, as in Trigonia, and is slightly grooved on its face; the anterior is linear and smooth, and the posterior is also smooth, at least on its posterior face. In the right valve the anterior tooth is as large as the middle, the posterior is linear.

? ISCHYRINA, Billings, 1866.

Distr.—Fossil, 2 sp. Silurian; Anticosti. *I. Winchelli*, Billings.

Shell equivalve, inequilateral, two strong ridges radiating from the beak in the interior of each valve.

CURTONOTUS, Salter, 1863.

Distr.—Fossil, 6 sp. Devonian; Britain. *C. elongatus*, Salter (cxxv, 24).

Shell elongately ovate; having a thickened hinge-plate, with a single strong triangular central tooth on each valve. Right valve plate with an obscure tooth behind the central one. Anterior muscular scar deep; pallial impression entire.

It seems very closely allied to Schizodus, but has not the broad median emarginated tooth in the left valve fitting into a special pit of the right valve; the forms of Curtonotus are also much more regularly oval.

DOLABRA, M'Coy, 1844.

Distr.—*D. corrugata*, M'Coy. Carboniferous; Ireland.

Shell ovate or trapezoid, gibbose, with a more or less straight hinge-margin, inequilateral, inequivalve, the left valve being larger than the right, hinge posteriorly with an elongated tooth, sometimes bifid in the left valve.

(*Arcacea.*)

FAMILY NUCULIDÆ.

Shell oval or trigonal, small, nacreous within; hinge composed of a great number of transverse teeth, interrupted by a central pit for the reception of the ligament, which is internal or external.

NUCULA, Lam.

Etym.—Diminutive of *nux*, a nut.

Syn.—Polydonta, Muhlf. Nuculites (part), Conrad.

Distr.—50 sp. Northern and Arctic seas; 10–180 fathoms. Siberia, Melville Island, New England, Britain, Mediterranean, Cape, Japan, Australia. Fossil, 250 sp. (50 Palæozoic, 30 Trias, 70 Cretaceous, 100 Tertiary.) United States, Europe, South India. *N. obliqua*, Lam. (cxxvi, 27).

Shell trigonal, with the umbones turned towards the short posterior side; smooth or sculptured, epidermis olive, interior pearly margins crenulated; hinge with prominent internal cartilage-pit, and a series of sharp teeth on each side; pallial line simple.

Animal with the mantle open, its margins plain; foot large, deeply fissured in front, forming when expanded a disk with serrated margins; mouth and lips minute, palpi very large, rounded, strongly plaited inside and furnished with a long convoluted appendage; gills small, plume-like, united behind the foot to the branchial septum.

The Nucula uses its foot for burrowing, and Professor Forbes has seen it creep up the side of a glass of sea-water. The labial appendages protrude from the shell at the same time with the foot.

ACILA, H. and A. Adams, 1858. Valves divaricately sculptured. 3 recent species. *N. divaricata*, Hinds (cxxvi, 28). Fossil. *N. ornatissima*, d'Orb. (cxxvi, 29). Cretaceous.

LEDA, Schumacher, 1817.

Etym.—*Leda*, in Greek mythology, mother of Castor and Pollux.

Syn.—Lembulus (Leach), Risso. Nuculana, Link. Dacryomya, Agass. Jupiteria, Bellardi. Junonia and Saturnia, Seguenza.

Distr.—80 sp. Northern and Arctic seas; 10–180 fathoms. Siberia, Melville Island, New England, Britain, Mediterranean, Cape, Japan, Australia. Fossil, 190 sp. Silur.—; United States, Europe, South India. *L. pernula*, Müll. (cxxvi, 31).

Shell resembling Nucula; oblong, rounded in front, produced and pointed behind; margins even; pallial line with a small sinus; umbonal area with a linear impression joining the anterior adductor.

Animal furnished with two partially united, slender, unequal, siphonal tubes; gills narrow, plume-like, deeply laminated, attached throughout; mantle-margin with small ventral lobes forming by their apposition a third siphon.

ADRANA, H. and A. Adams, 1858. Shell thin, gaping at the extremities. *L. Sowerbyana*, d'Orb. (cxxvi, 32).

NEILONELLA, Dall, 1881. Shell not gaping, epidermis polished, ligament central. *L. corpulenta*, Dall. Havana.

PERRISONOTA, Conrad, 1869. Shell elongated, posterior hinge-line long, curved, linear, with numerous close transverse teeth, extending nearly to the end margin; anterior hinge-area broad, oblique, and somewhat distant from the hinge-margin; no fosset under the apex? *L. protexta*, Con. Cretaceous; New Jersey.

YOLDIA, Möller, 1832.

Etym.—Dedicated to the Countess Yoldi.

Distr.—Arctic and Antarctic seas, Greenland, Massachusetts Brazil, Norway, Kamtschatka. *Yoldia limatula* has been dredged alive, by Mr. M'Andrew, on the coast of Finmark. It is also found in Portland Harbor, Maine. Fossil; Silur.—. *Y. myalis*, Couth. (cxxvi, 33).

Shell oblong, slightly attenuated behind, compressed, gaping, smooth or obliquely sculptured, with dark olive shining epidermis; external ligament slight; cartilage as in Leda; pallial sinus deep.

Animal (cxxvii, 61) with the branchial and anal siphons united, retractile; palpi very large, appendiculate; gills narrow, posterior; foot slightly heeled, deeply grooved, its margins crenulated; intestine lying partly close to the right side of the body, and producing an impression in the shell; mantle-margin plain in front, fringed behind; destitute of ventral lobes. The animal is very active, and leaps to an astonishing height, exceeding in this faculty the scollop-shells.

PORTLANDIA, Mörch. Valves posteriorly closed.

PHASELOTUS, Jeffreys. Like Yoldia, but teeth less numerous, moderately long, oblique, in two diverging rows. Recent and Pliocene.

MALLETIA, Desmoulins, 1832.

Syn.—Solenella, Sowb., 1832. Ctenoconcha, Gray, 1840.

Distr.—2 sp. Valparaiso; New Zealand. *M. Chilensis*, Desm. (cxxvi, 34). Fossil sp. Miocene; Point Desire, Patagonia; Italy.

Shell oval, compressed, smooth or concentrically furrowed, epidermis olive; ligament external, elongated, prominent; hinge with an anterior and posterior series of fine sharp teeth; interior subnacreous; pallial sinus large and deep; anterior adductor giving off a long oblique pedal line.

Animal like Yoldia; mantle-margins slightly fringed and furnished with ventral lobes; siphonal tubes united, long, and slender, completely retractile; palpi appendiculated, convoluted, as long as the shell; gills narrow, posterior; foot deeply cleft; forming an oval disk, even-margined and striated across.

NEILO, H. and A. Adams, 1855. Shell transverse, gaping, subtruncated, rostrated behind; surface concentrically striated; not nacreous within; cardinal hinge-line nearly straight. *M. Cumingii*, A. Adams (cxxvi, 35). Recent. *M. Monterosati*, Bell. Miocene; Italy.

TINDARIA, Bellardi, 1875. Shell thick, globose, oval, closed, beaks swollen; anterior teeth stronger, but the posterior row longer. *M. arata*, Bell. Pliocene; Asti, Italy.

NUCULARIA, Conrad, 1869. Shell thin, not pearly, ovately elongated, inequilateral, smooth; beaks pointed, subanterior; teeth angular, those of the posterior line complicated. *M. papyria*, Conrad (cxxvi, 36). Cretaceous; Haddonfield, N. J.

PHTHONIA, Hall, 1869.

Distr.—2 sp. Fossil; Hamilton Group, N. Y. *P. sectifrons*, Conrad (cxx, 8).

Shell thin, compressed, equivalve, transversely elongate-ovate, widening posteriorly and having small obscure subanterior beaks and an obscure angular umbonal ridge; surface covered by more or less distinct radiating striæ or costæ, which are crossed and cancellated by finer concentric lines, often forming rugæ or node-like markings on the rays; hinge apparently destitute of teeth; external ligament small, elongated; adductors small, superficial, pallial line apparently entire.

PALÆONEILO, Hall, 1870.

Distr.—15 sp. Palæozoic; U. S. *P. constricta*, Conr. *P. Bedfordensis*, Meek (cxxv, 25).

Shell Nuculiform, transversely ovate or subelliptical, the posterior end extended, often subrostrate, with a more or less defined sulcus along the umbonal slope; concentrically striated or ribbed; hinge-line more or less arcuate, crenulated throughout, not interrupted beneath the beak by a ligamental pit, but having an external ligament; muscular scars distant, faintly marked; several small pedal scars within the umbonal cavity; pallial line simple or obliquely truncate posteriorly.

Differs from Nucula in the want of a ligamental pit, in the teeth being continuous under the beaks, in having an external ligament, and in the sulcus on the posterior slope.

NUCULITES, Conrad, 1841.

Syn.—Cucullella, M'Coy, 1851. Cleidophorus, Hall, 1847.

Distr.—Silurian; New York, Europe. *N. ovatus*, Sowb. (cxxvii, 62).

Shell thin, margins not crenulated, ligament external; no cartilage-pit; teeth numerous, on a nearly straight cardinal line; anterior muscular scar bounded by a ridge; pallial line simple.

Cleidophorus, Hall, has been considered a synonym by Dr. Meek, who says that "the type species is now known to have a crenate hinge like Nucula," although the original description makes it toothless.

NYASSA, Hall, 1869.

Syn.—Modioconcha, Hall, 1869.

Distr.—4 sp. Palæozoic. *N. arguta*, Hall. Devonian; Ohio, New York.

Valves very oblique and transversely ovate in form; posterior hinge-plate narrow, bearing from one to four long slender ridge-like teeth; anterior plate broad, marked by numerous small, point-like teeth with intermediate depressions, arranged somewhat radiating from the middle of its inner border; adductor muscles two, one at each extremity; pallial line entire; ligament internal.

PTYCHOSTOLIS, Tullberg, 1881.

Distr.—Jurassic; Nova Zembla.

Shell obliquely oval; hinge-plate short with about eight denticles; anterior to the beaks a deep lunule, behind them a small escutcheon; under the last the margin of the shell forms two folds, forming a chamber communicating with the interior of the shell.

PHOLADELLA, Hall, 1869.

Distr.—5 sp. Fossil; Hamilton and Chemung Groups, N. Y.; Waverly Sandstones, Ohio. *P. radiata*, Conr.

Shell equivalve, inequilateral, transversely elongated, with more or less inflated valves, and strong, somewhat tumid incurved beaks situated near the anterior end. Valves crossed by a more or less distinct antero-mesial sinus constricting the basal margins, and also by a somewhat prominent umbonal ridge. Cardinal margin inflected, forming a more or less distinctly defined escutcheon and anterior lunette. Hinge characters and muscular impressions unknown; ligament external? Surface ornamented by oblique radiating ribs or striæ, which are mostly confined between the anterior prominence and the posterior umbonal ridge; while the anterior end and sometimes the posterior cardinal slope are without radii.

CIMITARIA, Hall, 1869.

Distr.—3 sp. Fossil; Hamilton Group, N. Y. *C. corrugata*, Conr. (cix, 88).

Shell bivalve, equivalve, inequilateral, transversely elongated, and more or less recurved with depressed convex valves, which have an antero-mesial constriction, slightly angular umbonal, and somewhat prominent incurved subanterior beaks; cardinal line recurved, bordered by a narrow escutcheon and lunette; posterior end truncate and usually nearly rectangular to the posterior part of the cardinal line. Surface marked by moderately strong irregular concentric undulations on the anterior end, which extend to the umbonal ridge and sometimes continue vertically across the cardinal slope. Some species are likewise marked by fine radiating lines of pustules on the body of the shell. Cardinal slope often marked by one or more radiating ridges; valves united by an external ligament. Hinge-teeth and muscular impressions undetermined.

? DYSTACTELLA, Hall and Whitfield, 1872.

Type, *Tellinomya subnasuta*, H. and W. Fossil; U. Helderberg, Kentucky.

Shell unequally ovate, twice as long as high, with very ventricose valves, giving a subcylindrical form anterior to the beaks; posterior end very narrow, pointed at the extremity; anterior end broadly rounded, longest above the centre, basal line very slightly insinuated, beaks small, appressed, at two-thirds the entire length from the anterior extremity; muscular impressions moderate in size, distinctly marked, situated near the margins; pallial line entire, composed of a series of radiating pustules, as seen on the cast; crenulations of the hinge not distinctly seen, but the evidence possessed would indicate them to have been minute.

FAMILY ARCIDÆ.

Shell regular, equivalve, with strong epidermis; ligament exterior, occupying an area between the beaks; hinge with a long row of similar, comb-like teeth; pallial line distinct; muscular impressions subequal. Structure corrugated, with vertical tubuli in rays between the ribs or striæ.—CARPENTER.

Animal with the mantle open; foot large, bent, and deeply grooved; gills very oblique, united posteriorly to a membranous septum.

ARCA, Linn.

Etym.—*Arca*, a chest.

Syn.—Navicula, Blainv., 1818. Byssoarca, Swains., 1840. Daphnæoderma, Poli, 1792.

Distr.—140 sp. World-wide, most abundant in warm seas; low water—230 fathoms (*A. imbricata*, Poli). Prince-Regent Inlet (*A. glacialis*). Fossil, 400 sp. Lower Silurian—; United States, Europe, South India. *A. Noæ*, Linn. (cxxvi, 39).

Shell equivalve or nearly so, thick, subquadrate, ventricose, strongly ribbed or cancellated; margins smooth or dentated, close or sinuated ventrally; hinge straight, teeth very numerous, transverse; umbones anterior, separated by a flat, lozenge-shaped ligamental area, with numerous cartilage-grooves; pallial line simple; posterior adductor impression double; pedal scars two, the posterior elongated.

Animal with a long pointed foot, heeled, and deeply grooved; mantle furnished with ocelli; palpi 0; gills long, narrow, less striated externally, continuous with the lips; hearts two, each with an auricle.

The name Byssoarca was chosen unfortunately by Swainson, for the typical species of the genus, in which the byssal orifice is sometimes very large. The byssus is a horny cone, composed of numerous thin plates, occasionally becoming solid and calcareous; it can be cast off and reformed with great rapidity. The Arcas with close valves often have the left valve a little larger than the right, and more ornate.

The Byssoarks secrete themselves under stones at low-water, in crevices of rocks, and the empty burrows of boring mollusks; they are often much worn and distorted.

A large number of genera and subgenera have been formed out of the Linnæan Arca, but as in Helix, Murex and other well-known and well-characterized groups, these groups possess but slight value; the most important of them may be considered subgenera, perhaps; others as sections.

ARCA, Linn. (typical). Shell oblong, subquadrangular, gaping anteriorly or inferiorly; hinge linear, straight, formed of a large number of small pectinated teeth; ligament external, inserted upon a lozenge-shaped area between the beaks; beaks high, rather wide apart; muscular impressions very distinct; pallial impression entire. *A. Noæ*, Linn. The Arcas often anchor themselves by means of a strong byssus to rocks or stones.

BARBATIA, Gray, 1840. Shell oblong, oval or subquadrangular; surface covered by a rude, caducous epidermis; hinge-line straight or somewhat curved; teeth numerous, the central ones smallest, the lateral ones becoming gradually larger and more oblique towards the extremities; ligament external, inserted upon a narrow surface between the approaching beaks. *A. velata*, Sowb. (cxxvi, 40).

POLYNEMA, Conrad, 1875. Shell transversely trapezoid-ovate, narrowing anteriorly; cardinal margin descending forward, and meeting the anterior and posterior margins at more or less defined angles; cardinal area extremely narrow, with about two deep, divaricating cartilage-furrows; lateral denticles very oblique, those on the posterior side more elongated and striated;

surface with fine radiating striæ. *Barbatia lineata*, Conrad (cxxvii, 65). Cret.; North Carolina.

ACAR, Gray. Valves cancellate or costellate; posterior slope subcarinated or angulated. *A. Donaciformis*, Reeve (cxxvi, 41).

CALLOARCA, Gray, 1857. Shell with the posterior slope strongly carinated, and that and the anterior slope both strongly ribbed, the ribs forming marginal teeth within. *A. alternata*, Reeve (cxxvi, 42).

STRIARCA, Conrad, 1862. Shell oblong, with a depression running from the beak to the ventral margin, which is somewhat insinuated, no doubt corresponding to a small gape; the surface is radiately striated; the ligamental area and hinge-teeth are quite similar to those of Barbatia. *A. centenaria*, Say (cxxvii, 66, 67). Miocene; U. S.

PLAGIARCA, Conrad, 1875. Shell transversely trapezoidal, with hinge nearly straight, and meeting the lateral margins at more or less defined angles; lateral denticles very oblique, one or two of the anterior series being comparatively large and slightly angulated in the middle; surface radiately costate; area very narrow, and marked by numerous minute, crowded, divaricating cartilage-furrows. *Arca Carolinensis*, Conr. (cxxvii, 79). Cret.

GRANOARCA, Conrad, 1862. (Cucullæarca, Conrad, 1865.) Equivalve, gaping anteriorly; hinges rather wide and very oblique, with longitudinal grooves angulated under the back; tooth more or less divided into granular plates, posteriorly widely expanded and broken into irregular granules. *A. propatula*, Conr. (cxxix, 5). Miocene; U. S.

LITHARCA, Gray, 1840. Shell cuneiform, obliquely truncated behind, elongated and rounded in front, gaping inferiorly; no teeth behind the beaks. *A. lithodomus*, Sowb. (cxxvii, 68). Recent.

ANOMALOCARDIA, Klein, 1753. (Anadara, Gray, 1847.) Shell thick, subcordiform or subquadrangular, equivalve, subequilateral; valves radiately costate, with a smooth or rugose olive epidermis; hinge-line nearly straight, with numerous teeth, smallest in the middle, largest at the extremities. Differs from Barbatia principally in form. *A. auriculata*, Lam. (cxxvi, 43).

SCAPHARCA, Gray, 1847. Shell oval or oblong or subquadrangular, thin, radiately ribbed, with a light epidermis; inequivalve, one valve overlapping the other considerably on the inferior margin; teeth subequal, dilated, more or less oblique. *A. inequivalvis*, Brug. (cxxvi, 44).

NEMOARCA, Conrad, 1869. Shell elongately trapezoidal, subequilateral, tumid, radiately ribbed; ligamental area narrow; hinge-line straight, with small transverse teeth. *A. cretacea*, Conrad (cxxvi, 48).

SENILIA, Gray, 1847. Shell thick, solid, triangular, subcordiform, subequilateral, equivalve; surface with a few large, flat, radiating

ribs, and narrow intervening furrows; epidermis smooth, olive; teeth large, oblong, arcuated on each side. *A. senilis*, Linn. (cxxvi, 45).

ARGINA, Gray, 1840. Shell subglobose, subcordiform, equivalve, inequilateral; covered with radiating ribs and a brown, hairy epidermis; teeth numerous, elongated, curved, the central ones very small. *A. pexata*, Say (cxxvi, 46, 47).

ISOARCA, Münster, 1842. Shell ventricose; beaks large, anterior, often subspiral; ligament entirely external; hinge-line curved, with transverse teeth, smallest in the centre; pallial line simple. *I. Logani* (Ctenodonta), Salter, Lower Silurian, Canada, is 3 inches long, and has the ligament preserved. Fossil, 14 sp. Lower Silurian—Cretaceous; North America, Europe. *I. texta*, Münst. (cxxvii, 69).

CARBONARCA, Meek and Worthen, 1875. Shell (as determined from internal casts) equivalve, inequilateral, very convex, transversely oblong or oval; umbones gibbous, prominent, and strongly incurved with subangular or prominent posterior slopes; valves closed all around, with smooth margins; ligament external; cardinal margin a little arched, with, at the anterior extremity in each valve, two rather oblique comparatively stout teeth, and extending along its entire length from immediately behind these, a row of minute, interlocking teeth or crenulations as in Arca. *C. gibbosa*, M. and W. (cxxvii, 71). Upper Coal-measures, Ills.

LUNARCA, Gray, 1842. Shell globose, subcordiform, nearly equivalve; surface radiately costate, with brown, foliaceous epidermis; hinge with the posterior tooth elongated; narrow in the middle; the front tooth of the left valve ovate; elevated, entire, fitting into a cavity in the inner edge of the front margin of the right valve. *A. costata*, Gray (cxxvi, 49).

NOETIA, Gray, 1842. Shell trigonal, ventricose, inequilateral, equivalve; posterior side truncate, strongly angulate; teeth smallest in the middle, anteriorly elongated, posteriorly arcuated. *A. ponderosa*, Say (cxxviii, 84, 85).

GLYPTARCA, Hicks, 1872. Inequilateral, strongly ventricose; beak near the anterior end, prominent, overhanging the hinge-line more or less and pointed at the extremity; two diverging ridges extend from the umbo to the margin, and enclose a triangular sulcus, having its base at the margin, which it thereby indents; anterior muscular impression strong, posterior less distinct; hinge-area narrow, plate thick, with three teeth in front of the umbo; surface strongly marked with growth-lines. 2 sp. Silur.; Wales. *A. primæva*, Hicks (cxxvi, 37, 38).

MACRODON, Lycett, 1845.

Syn.—Parallelodon, Meek and Worthen.

Distr.—Oolite—Recent. *M. asperula*, Dall. Yucatan. Fossil. *M. Hirsonensis*, d'Arch. (cxxvii, 72).

Shell thick, subrhomboidal, beaks anterior; hinge with a few oblique anterior teeth, and one or more long, laminar posterior teeth, parallel with the hinge-line.

CUCULLARIA, Deshayes, 1860. Shell elongated, suboval, moderately inflated, radiately striated, inequilateral, beaks subanterior, incurved, very close together, the hinge-area being very narrow and almost wanting in some species; hinge-line moderately curved with a few shorter anterior and some longer posterior fold-like teeth, arranged almost parallel to it; numerous subequal teeth are situated below the beaks. *Arca heterodonta*, Desh. (cxxvii, 80, 81). From the Paris Basin.

NEMODON, Conrad, 1869. Shell elongated, form resembling Macrodon, but of thin structure; hinge-area very narrow, hinge-line long, straight, or slightly curved under the beaks, "with three linear teeth parallel with the anterior cardinal margin" in the left valve, and with a double posterior lateral tooth, being very long and linear; under the beaks a few granular teeth are present. *M. Eufalensis*, Conrad (cxxvi, 50, 51). Scarcely distinct from the typical Macrodon.

GRAMMATODON, Meek and Hayden, 1860. Appears to be distinguished only by the posterior muscular impression not being raised upon a projecting lamina. Jurassic; U. S. Type, *M. inornata*, M. and H.

Parallelopipedum, Klein, 1753.

Distr.—2 sp. China. *P. tortuosum*, Lam. (cxxvii, 73).

Shell subquadrangular or mytiliform, subequivalve, carinated, twisted so that the straight hinge-line is oblique instead of transverse to the beaks; teeth numerous, middle ones smallest, lateral ones larger and oblique.

Scaphula, Benson, 1834.

Distr.—Fresh water, India, Burmah.

Shell thin, elongated, subtrapeziform, equivalve, very inequilateral, carinated behind; valves covered with a thin, smooth epidermis; hinge edentulous in the centre, posterior teeth laminar and branched.

S. pinna, Benson (cxxvi, 52), is found in the Ganges and its branches, from Calcutta to Humeerpoor on the Jumna, 1000 miles from the sea. A second species has been found in the river Tenasserim, Burmah.

Cucullæa, Lamarck, 1801.

Etym.—*Cucullus*, a cowl.

Distr.—2 sp. Mauritius, Nicobar, China. Fossil, 240 sp. Lower Silurian; North America, Patagonia, Europe. *C. concamerata*, Mart. (cxxvii, 74).

Shell subquadrate, ventricose; valves close, striated; hinge-teeth few and oblique, parallel with the hinge-line at each end; posterior muscular impression bounded by an elevated ridge.

IDONEARCA, Conrad, 1862. Shell thicker than the type, with a wider hinge-plate and fewer of the short mesial denticles, which are prominent and transversely striated; lateral denticles long, horizontal, or descending outward, and bent downward at the inner ends, strongly cross-striated; laminæ of posterior muscular scars prominent. Cretaceous; Amer. and Eur. *Cucullæa Tippana*, Conr.

LATIARCA, Conrad, 1862. Shell very thick and strong; hinge comparatively narrow, and occupied by very irregular, strong, vertical denticles, excepting at each end, where it is broad, and occupied by strong, rugosely-striated, longer denticles, declining outward, and bent downward at the inner ends; posterior muscular scars, with their lower margins somewhat raised and acute, but not forming a projecting lamina. *Cucullæa onoclea*, H. D. and W. B. Rogers. Eocene.

TRIGONARCA, Conr., 1862. Shell subtrigonal or subtrapezoidal, with posterior margin obliquely truncated, and posterior basal extremity more or less angular; posterior umbonal slopes prominently rounded or angular; hinge-area divaricately furrowed; hinge-teeth rather strong. *C. triquetra*, Conr. (cxxix, 6).

BREVIARCA, Conr., 1872. Shell small, suborbicular or suboval, more or less rounded at the extremities, or rarely truncated obliquely behind; surface nearly smooth, or finely radiately striated; hinge-area with minute cross-striæ; hinge-denticles very fine and crowded. *C. perovalis*, Conrad (cxxvii, 82). Cretaceous.

CYPRICARDITES, Conrad, 1841; Hall, 1868.

Syn.—Cyrtodonta, Vanuxemia, Billings, 1858. Palæarca, Hall, 1859.

Distr.—60 sp. Silurian, Devonian; N. America, Wales.

Shell ventricose, suborbicular or broad-ovate in outline, with an external flattened ligamental area; cardinal teeth four to five, short, oblique; lateral teeth two or more, oblique; muscular impressions two (anterior one single?); pallial line simple.

MEGALOMUS, Hall, 1852. Shell ventricose, ponderous; beaks strong, incurved, anterior; hinge-plate with several oblique tuberculose teeth at the anterior end, subject to absorption; lateral teeth none; ligament external; anterior muscular scar double, one large and deep, the other minute; posterior scar very large, obscure; pallial line simple. Palæozoic; U. S. *C. Canadensis*, Hall (cxxix, 7). See p. 207. The genus is better placed here, and the above description is the most correct.

ÆGILOPS, Hall, 1850. Described from a cast, impossible to determine. Has the form of Cypricardites.

MEGAMBONIA, Hall, 1859. Shell ventricose, broad-ovate or suborbicular; anterior end with a ventricose wing or extension, separated from the body of the shell by a deep curved sinus; anterior hinge-teeth unknown; lateral teeth two to three, short, small and oblique; ligamental area narrow or obsolete; anterior muscular scar deep, circular, and having a small pedal scar upon its upper margin; posterior scar larger, faintly impressed; pallial line simple. *C. aviculoidea*, Hall (cxxix, 9).

ADRANARIA, Munier-Chalmas, 1876.

Syn.—Siliquarca, Pseudarca, Tromelin and Lebesc.

Distr.—2 sp. Palæozoic; France. *A. Tromelini*, M.-C.

Shell equivalve, recalling Cultellus by its general form; hinge with a series of oblique linear, nearly parallel teeth, the anterior ones narrower and more divergent, the posterior more numerous; a rib within each valve passes in front of the anterior muscular impression.

CARDIOLA, Broderip, 1834.

Distr.—17 sp. U. Sil.—Devon.; Eur., U. S. *C. cornucopiæ*, (cxvi, 94).

Shell somewhat inequilateral or subequilateral, roundly ovate, with the beaks incurved anteriorly and with a rather large ligamental area between both; hinge-line slightly curved with numerous oblique pliciform teeth, being apparently present on both sides of the beak; surface generally radiately striated or ribbed.

LYRODESMA, Conrad, 1841.

Syn.—Actinodonta, Phil.

Distr.—Fossil, 4 sp. Lower Silurian; Canada, United States, Britain. *L. pulchella*, Hall (cxxvii, 83).

Shell Trigonia-shaped, rather elongated, with a striated posterior area; hinge with several (5–9) radiating teeth, striated across; ligament external.

Lyrodesma appears to connect the Pectunculus with the Arcinæ.

PECTUNCULUS, Lam.

Syn.—Axinæa, Poli, 1791. Tuceta, Bolten.

Distr.—58 sp. West Indies, Britain, India, New Zealand, West America; ranging from 8 to 60, rarely 120 fathoms. Fossil, 80 sp. Neocomian—; Europe, United States, South India. *P. Delesserti*, Reeve (cxxvii, 53).

Shell orbicular, nearly equilateral, smooth or radiately striated; umbones central, divided by a striated ligamental area; hinge with a semicircular row of transverse teeth; adductors subequal; pallial line simple; margins crenated inside.

Animal with a large crescent-shaped foot, margins of the sole

undulated; mantle open, margins simple, with minute ocelli; gills equal, lips continuous with the gills.

The teeth of Pectunculus and Arca increase in number with age, by additions to each end of the hinge-line, but sometimes the central teeth are obliterated by encroachments of the ligament.

CNISMA, Mayer. Small, obliquely oval, very inequilateral, margin smooth; hinge very thick, with three anterior and four posterior teeth. *P. nuculatus*, Lam. Eocene.

LIMOPSIS, Sassi, 1827.

Syn.—Pectunculina, d'Orb., 1844.

Distr.—5 sp. Red Sea (Nyst.), Japan, Britain. Mr. M'Andrew has dredged *L. pygmæa*, living, on the coast of Finmark; it is a fossil of the Pliocene of England, Belgium and Sicily. Fossil, 36 sp. Trias—; United States, Europe. *L. complanata*, Orb. (cxxvii, 75). *L. alter*, Desh. (cxxvii, 76). *L. Gyssei*, Raincourt (cxxx, 36, 37).

Shell orbicular, convex, slightly oblique; ligamental area with a triangular cartilage-pit in the centre; hinge with two equal, curved series of transverse teeth.

TRIGONOCŒLIA, Nyst., 1836. (Trinacria, Mayer.) Shell approaches Leda in form, and differs from Limopsis in the absence of the expanded ligamental area. Fossil, 7 sp. Eocene; Paris Basin, Belgium, England, United States. *L. inequivalvis*, d'Orb. (cxxvii, 77).

CYRILLA, A. Adams. (Huxleya, A. Adams, 1860.) Shell oblong, oblique, very inequilateral, covered with a thin epidermis; hinge with six diverging, sharp teeth, directed posteriorly, and terminating with a curved lamina; ligament situated in a small pit under the beak. *L. sulcata*, H. Ad., from the Straits of Korea, dredged from 63 fathoms.

NUCUNELLA, d'Orb., 1850.

Syn.—Nuculella, Chenu. Stalagmium, Nyst. (in part).

Distr.—*N. Nysti*, Galeotti (cxxvii, 54, 55). Tertiary; Belgium.

Shell suborbicular, slightly inequilateral, beaks close together; hinge-line curved, with numerous cross-pliciform teeth, interrupted under the beaks by an oblique, simply granular pit, this last appearing to have been for the ligament, which must at least have been partially internal.

? CYTHERODON, Hall, 1873.

Distr.—4 sp. Palæozoic; Hamilton Group, U. S. *C.* (*Nuculites*) *appressus* Conr. (cxxvii, 63, 64).

Shell subtrapezoidal, with prominent beaks and posteriorly

angulate like Cucullæa; hinge with about four cardinal teeth in the right and five in the left valve.

CTENODONTA, Salter, 1851.

Syn.—Tellinomya, Hall.

Distr.—Fossil, 40 sp. Silurian—Carboniferous; Europe, N. America, Bolivia. *C. pectunculoides*, Hall (cxxvi, 30).

Shell elongately oval, subequilateral, smooth, or finely concentrically striate, valves moderately convex, hinge represented by two diverging comb-like denticulated margins without a special hinge-area between them and the beak, and below the latter, not interrupted by a pit; ligament apparently external, posterior to the beak.

From Malletia the shells would seem only to differ by a more elongated and more tumid form.

It is probable that most of the palæozoic species referred to Nucula belong to Ctenodonta.

TELLINOMYA, Hall, 1847. Has been considered a synonym of Ctenodonta; perhaps some species referred to it really belong here. Many of the palæozoic genera are very difficult to classify, because they are frequently not well-preserved, and the essential characters are consequently wanting. *T. nasuta*, Hall. 35 sp.

SAREPTA, A. Adams, 1860.

Distr.—*S. speciosa*, A. Ad. Japan.

Shell oval, equivalve, not pearly within; hinge-line nearly straight, provided with numerous denticles, cartilage internal, below the beak; muscular impressions distant, pallial line entire.

"This genus," says the author, "agrees with Nucula in the simple pallial line and internal ligament, and with Malletia in not being nacreous or pearly within, and in general form and character." Is possibly a recent representative of the fossil genus Ctenodonta.

CARDIOLARIA, Munier-Chalmas, 1876.

Distr.—*C. Barrandei*, M.-C. Palæozoic; France.

Shell equivalve, thin and subcircular, convex; hinge with a series of teeth similar to Nucula, the posterior ones the smallest and most numerous; pallial line simple; anterior muscular impression more developed than the posterior.

NUCINELLA, S. Wood, 1848.

Syn.—Nuculina, d'Orb., 1844. Pleurodon, Wood, 1840.

Distr.—Fossil. *N. miliaris*, d'Orb. (cxxvii, 78).

Shell oval or subtrigonal, equivalve, inequilateral; hinge wide and curved, with sparse transverse teeth, and a long lateral tooth on the longer anterior side; muscular impressions unequal, the

anterior oval; pallial line simple; ligament external, contained in a very small pit.

Suborder *HETEROMYARIA.*

Frequently inequivalve; anterior muscular impression very small, posterior impression large.

(*Mytilacea.*)

Family MYTILIDÆ.

Shell equivalve, oval or elongated, closed, umbones anterior, epidermis thick and dark, often filamentose; ligament internal, submarginal, very long; hinge edentulous; outer shell-layer obscurely prismatic-cellular; inner more or less nacreous; pallial line simple; anterior muscular impression small and narrow, posterior large, obscure.

Animal marine or fluviatile, attached by a byssus; mantle-lobes united between the siphonal openings; gills two on each side, elongated, and united behind to each other and to the mantle, dorsal margins of the outer and innermost laminæ free; foot cylindrical, grooved.

The members of this family exhibit a propensity for concealment, frequently spinning a nest of sand and shell-fragments, burrowing in soft substances, or secreting themselves in the burrows of other shells.

The Mytilidæ appear in the palæozoic strata, and continue in increasing variety and number of species to the present time.

Subfamily *MYTILINÆ.*

Shell elongated with subterminal or terminal and pointed beaks; hinge toothless; anterior muscular scar small, marginal, posterior scar large and elongated; pallial line entire.

Mytilus, Linn., 1758.

Sea-mussel.

Distr.—65 sp. World-wide. Ochotsk, Behring's Sea, Russian Ice-meer; Black Sea, Cape Horn, Cape, New Zealand. Fossil, 100 sp. Silurian—; United States, Europe, South India. *M. smaragdinus*, Chemn. (cxxviii, 4).

Shell wedge-shaped, rounded behind, smooth in the typical species; umbones terminal, pointed; hinge-teeth minute or obsolete; pedal muscular impressions two in each valve, small, simple, close to the adductors.

Animal with the mantle-margins plain in the anal region, and projecting slightly; branchial margins fringed; byssus strong and coarse; gills nearly equal; palpi long and pointed, free.

The common edible mussel frequents mud-banks which are uncovered at low-water; the fry abound in water a few fathoms deep; they are full-grown in a single year. From some unknown cause they are at times extremely deleterious. The consumption of mussels in Edinburgh and Leith is estimated at 400 bushels (= 400,000 mussels) annually; enormous quantities are also used for bait, especially in the deep-sea fishery, for which purpose thirty or forty millions are collected yearly in the Frith of Forth alone.—Dr. KNAPP. Mussels produce small and inferior pearls. At Fort Stanley, Falkland Islands, Mr. Macgillivray noticed beds of mussels which were chiefly dead, being frozen at low-water.

The species of Mytilus are usually found attached by a byssus in masses to stones, wrecks or floating bodies. The ligulate grooved foot has the power of spinning the silky material of the byssus whenever the animal requires temporarily to anchor itself.

Boughs of elm and other trees are laid down in the Bay of Kiel, and taken up at the end of three, four, or five years, between December and March, being then covered with fine mussels. These laden boughs are sold by weight, and the shell harvest is sent into the interior of Germany, where it is in great request.

AULACOMYA, Mörch. (Hormomya, Mörch. Arcomytilus, Agass.) Surface ornamented with radiating ribs. *M. decussatus*, Lam. (cxxviii, 92).

CALOROMYA, Mörch. *M. afer*, Gmel. (cxxviii, 93).

MYTILOCONCHA, Conr., 1862. Subfalcate, thick, perlaceous, laminated; hinge thick, elongated; pointed at the apex; an oblique tooth or ridge and parallel furrow throughout the entire length of hinge-area. *M. incurva*, Conr. (cxxii, 11).

BYSSOPTERIA, Hall, 1883. Shell erect, alate posteriorly, truncate with a nasute projection in front; surface radiated. *M. radiata*, Hall. Fossil; Chemung Group, N. Y.

MYTILOPS, Hall, 1883. Shell resembling Modiola and Lithodomus in external form, and may also be compared with the fossil genus Myoconcha; hinge-line narrow, oblique, extending about one-half the length of the shell; beaks terminal. 4 sp. Chemung Group, New York. *M. præcedens*, Hall.

STAVELIA, Gray, 1857. Shell inequivalve, inferior margin sinuous. *M. torta*, Dunker.

MODIOLA, Lam., 1799.

Etym.—*Modiolus*, a small measure, or drinking-vessel. Horse-mussel.

Syn.—Perna, Adanson, H. and A. Adams. Amygdalum, Muhlf. Callitriche, Poli.

Distr.—70 sp. Universal. Chiefly tropical. *M. modiolus*. Arctic seas—Britain. Fossil, 150 sp. Silurian? Lias—; United

States, Europe, Thibet, South India. *M. barbata*, Linn. (cxxviii, 94). *M. tulipa*, Linn. (cxxviii, 95).

Shell oblong, inflated in front; umbones anterior, obtuse; hinge toothless; pedal impressions three in each valve, the central elongated; epidermis often produced into long beard-like fringes.

Animal with the mantle-margin simple, protruding in the branchial region; byssus ample, fine; palpi triangular, pointed.

The Modiolæ are distinguished from the mussels by their habit of burrowing, or spinning a nest, using stones, fragments of shells and the byssal threads. The common American species, *M. plicatula*, however, adheres by its byssus in masses like Mytilus. Low-water—100 fathoms.

BRACHYDONTES, Swainson, 1840. Shell radiately ribbed, cardinal margin angular and sometimes crenulated. *M. plicatula*, Lam. (cxxviii, 96).

ADULA, H. and A. Adams, 1855. Shell elongated, cylindrical, posterior margin obliquely truncated; beaks submedian. *M. Soleniformis*, d'Orbigny (cxxix, 12).

MODIELLA, Hall, 1883. Subrhomboidal, narrowed and auriculate in front, broadly expanding posteriorly; two well-marked muscular impressions, connected by a simple pallial line; surface with radiating striæ. *M. pigmæa*, Conrad. Hamilton Gr., N. Y.

LITHODOMUS, Cuvier, 1817.

Syn.—Lithophaga, Bolten, H. and A. Adams. *L. caudigerus*, Lam. (cxxviii, 97). *L. lithophaga*, Linn. (cxxviii, 98).

Distr.—40 sp. West Indies—New Zealand. Fossil, 35 sp. Carb.—; Europe, United States.

Shell cylindrical, inflated in front, wedge-shaped behind; epidermis thick and dark; interior nacreous.

These mollusks, when young, suspend themselves to rocks by a byssus, but when adult they form cavities corresponding to the shape of their shells in soft rocks or other shells. *L. dactylus* is sold by the Mediterranean fishermen as an article of food, and is highly esteemed. Like other burrowing shell-fish, they are luminous. Perforations of Lithodomi, in limestone cliffs, and in the columns of the Temple of Serâpis at Puteoli, have afforded conclusive evidence of changes in the level of sea-coasts in modern times.

BOTULA, Mörch. Shell oblong, subrhomboidal, subcylindrical; beaks distant, subterminal. *L. splendida*, Dunker (cxxix, 16).

LEIOSOLENUS, Carpenter, 1856. The cavity or burrow formed by the animal with the aperture prolonged into a tube, more or less bilobed at the outer end, contracted at the junction. *L. spatiosa*, Carpenter.

adductor supported on a shelf within the beak; pedal impression single, posterior.

Animal with the mantle closed; byssal orifice small; anal siphon very small, conical, plain; branchial prominent, fringed inside; palpi small, triangular; foot-muscles short and thick, close in front of the posterior adductor.

D. polymorpha (cxxviii, 100; cxxix, 24) is a native of the Aralo-Caspian rivers; in 1824 it was observed by Mr. J. Sowerby in the Surrey docks, to which it appears to have been brought with foreign timber, in the holds of vessels. It has since spread into the canals, docks, and rivers of many parts of England, France and Belgium, and has been noticed in the iron water-pipes of London, incrusted with a ferruginous deposit.

MYTILOPSIS, Conrad, 1857. (Praxis, H. and A. Ad., 1857.) Shell with a lamina on the hinge-shelf or septum. *D. Sallei*, Recluz (cxxix, 22). *D. leucophæata*, Conrad. Brackish waters of Chesapeake Bay, on oysters.

DREISSENOMYA, Fuchs. Septum transformed into a regular, large, anterior muscular scar, pallial line with a deep posterior sinus. *D. Schröckingeri*, Fuchs. Upper Tertiary; Hungary.

SEPTIFER, Recluz, 1848.

Distr.—Warm seas. Fossil; Jurassic and Cretaceous. *S. Heberti*, Desh. (cxxix, 23).

Shell equivalve, very inequilateral; ventral margin subconcave and cut out for the passage of the byssus; beaks subterminal, curved; hinge without teeth, furnished with a lamellar septum; ligamental pits linear, marginal, dorsal, anterior, with a white, nearly spongy margin within; muscular impressions superficial, the anterior small, rounded, the posterior large, subdorsal, uniform.

Animal marine, byssiferous.

MYALINA, Koninck, 1842.

Distr.—Fossil, 6 sp. Silur., Carb.—Permian; Europe. *M. lamellosa*, Koninck (cxxix, 25).

Shell equivalve, mytiliform; beaks nearly terminal, septiferous internally; hinge-margin thickened, flat, with several longitudinal cartilage-grooves; muscular impressions two; pallial line simple. The ligamental area resembles that of *Arca obliquata*, Chemn.

ANTHRACOPTERA, Salter, 1863.

Syn.—Naiadites, Dawson, 1855 (part).

Etym.—*Anthrax*, coal, and *pteron*, a wing.

Distr.—Fossil, 10 sp. Carboniferous; Great Britain, Westphalia, Nova Scotia, United States.

This genus includes several so-called Myalinæ, but they have not the thick hinge-plate of the shells of that genus, and species which have been described by Ludwig as belonging to Dreissensia. The form of the shell is triangular.

HOPLOMYTILUS, Sandberger, 1850.

Distr.—Devonian; Nassau. *H. crassus*, Sandb. (cxxix, 26).

Shell equivalve, triangular, pyramidal, sides incurved, wider in front, angular behind, beaks contiguous; hinge with an elongated septum under the beak, followed by a longitudinal tooth in the right and a corresponding pit in the left valve.

PACHYMYTILUS, Zittel, 1881.

Distr.—Jurassic. *P. petasus*, d'Orb. (cxxix, 10).

Shell triangular, very thick and massive, with terminal, prominent beaks, and usually smooth surface; anterior to the beak the slope is angularly pinched in, and on the anterior margin, just under the beak, are two fold-like, tubercular teeth; hinge-margin very thick.

SUBFAMILY *PRASININÆ.*

Shell elongated, very inequilateral, smooth, beaks moderately tumid; hinge with one elongated cardinal tooth in each valve; ligament external, long, supported by thickened fulcra.

In Modiolopsis and Phaseolicama no hinge-teeth have been observed.

HIPPOPODIUM, Sowb., 1821.

Distr.—Jurassic; Europe. *H. ponderosum*, Sowb.

Shell oblong, thick, ventricose; umbones large; ligament external; ventral margin sinuated; hinge with one thick, oblique tooth in each valve, sometimes nearly obsolete; pallial line simple; anterior muscular scar deep. This shell appears like a ponderous form of Cypricardia or Cardita; it is a characteristic fossil of the English Lias, but only very aged examples have been found.

JULIA, Gould, 1862.

Syn.—Prasina, Deshayes, 1863.

Distr.—*J. Borbonica*, Desh. (cxxviii, 1–3). Isle of Bourbon. *J. exquisita*, Gould. Sandwich Islands.

Shell oblong, thick, cordiform, valves closed, margins entire, inequilateral; lunule deep circular, projecting into the interior of the right valve, left valve in the same place furnished with dentiform tubercles; hinge-line simple, arched; ligament external, narrow; muscular scars two, unequal, subcentral.

Very closely allied to, perhaps not generically distinct from, Hippopodium.

SUBFAMILY *CRENELLINÆ*.

Shell elongately tumid, thin, with subterminal slightly swollen beaks, two muscular scars, of which the posterior is larger, outer surface of valves entirely or partially radiately striated (except in Myrina); hinge-line often denticulate; ligament almost quite internal, in a linear groove, more or less extending posteriorly.

CRENELLA, Brown, 1827.

Etym.—Diminutive of *crena*, a notch.

Syn.—Myoparo, Lea, 1833. Stalagmium, Conr., 1833.

Distr.—5 sp. Low-water mark to 150 fathoms. Norway, Iceland, Greenland, New England, Britain, France. Fossil. Eocene; Ala. *C. rhombea* occurs in a fossil state in the Coralline Crag, England. *C. decussata*, Mont. (cxxix, 17).

Shell oval or rhomboidal, nacreous, cancellated; umbones straight, ligament small, hinge of each valve furnished with an upright tooth, which is crenulated, as well as the hinge-plate.

Animal with the mantle open in front, and folded behind into a sessile excurrent tube; foot cylindrical, the free end being disk-like and issuing out of a sheath. The animal does not spin a thick byssus, like Modiolaria, but secretes only a single thread for attachment, and by means of which it holds itself suspended in the water.

NUCULOCARDIA, d'Orb., 1843. Shell with large anterior crenate teeth, and smaller posterior ones. *C. divaricata*, d'Orb. (cxxix, 18).

DACRIDIUM, Torell, 1859. Hinge-crenulations tuberculiform anteriorly, elongate posteriorly. *D. vitrea*, Sars (cxxix, 19).

MODIOLARIA, Beck (Jeffreys, 1863).

Etym.—Allied to the genus Modiola of Lamarck.

Syn.—Lanistes, Humphreys. Lanistina, Gray.

Distr.—Temperate and Arctic seas. The four British species occur fossilized in the Red and Coralline Crags and newer Tertiaries. Several species in the Upper Triassic and Jurassic formations, referred to Modiola, appear to belong here. *M. impacta*, Herm. (cxxviii, 99).

Shell rhomboidal, sculptured by two rows (one on each side) of striæ, which radiate from the beaks, leaving the middle portion smooth, umbones incurved, hinge edentulous or crenulated, hinge-plate finely notched.

Animal with the mantle folded in front into a wide incurrent tube, and behind into a conical excurrent tube; foot strap-shaped.

ARCOPERNA, Conrad, 1865.

Distr.—Eocene; Mississippi, Paris Basin. *A. filosa*, Conrad (cxxix, 20).

Shell oval or oblong, thin, moderately inflated, with terminal, or very nearly terminal, incurved beaks, surface finely or radiately striated, somewhat stronger anteriorly, producing a distinct crenulation at the margin; hinge edentulous, ligament thin, long, situated in a fine marginal furrow of the internal side; muscular scars distinct, the anterior slightly smaller than the posterior, pallial impression simple.

Conrad says that Deshayes' *Mod. radiolata* (Paris foss., 2d ed., vol. ii, p. 22) is congeneric with the above species. Its relation to the short, oval species of Modiola is very great, but the well-marked and comparatively large anterior muscular scar, internal ligament, and fine radiating striation may serve as distinction. In general character Arcoperna strongly recalls the type of Phaseolicama. It is not improbable that the recent *Lith. cinnamominus*, Chemn., is a recent representant of Arcoperna, while, on the other hand, cretaceous species, like *Mytilus pileopsis*, d'Orb., and a few others, are equally correctly referable to it, as to Crenella, or to any of the allied genera.

Myrina, H. and A. Adams, 1857.

Distr.—*M. pelagica*, Forbes (cxxix, 21). On floating blubber, off the Cape of Good Hope.

Shell transverse, oblong, subequilateral, close, smooth, covered by a corneous epidermis; nacreous within; beaks submedian; hinge edentulous; ligament internal, linear; anterior muscular impression large.

Animal byssiferous, mantle open.

Subfamily *DREISSENSINÆ.*

Anterior muscular scar resting on a thickened plate near the apex of the shell, hinge sometimes with an obsolete, long tooth, fulcra of ligament strong; pallial line entire, rarely sinuated.

The animal has closed mantle and short siphons, and would therefore go into the order Siphonida, suborder Integripalliata; but the mollusk and its shell are otherwise too closely related to Mytilus to admit of such a separation.

Dreissenssia, Van Beneden, 1836.

Etym.—Dedicated to Dreyssens, a Belgian physician.

Syn.—Mytilina and Mytilomya, Cantr., 1847. Congeria, Partsch, 1836. Tichogonia, Rossm., 1835. Enocephalus, Munster, 1831.

Distr.—15 sp. Europe, America, Africa. Fossil, 13 sp. Eocene—; Britain, Germany.

Shell like Mytilus, without its pearly lining; inner layer composed of large prismatic cells; umbones terminal; valves obtusely keeled; right valve with a slight byssal sinus; anterior

(*Aviculacea.*)

The following families are often included in Monomyaria:

FAMILY AVICULIDÆ.

Shell inequivalve, very oblique, resting on the smaller (right) valve, and attached by a byssus; epidermis indistinct; outer layer prismatic-cellular, interior nacreous; posterior muscular impression large, subcentral, anterior small, within the umbo; pallial line irregularly dotted; hinge-line straight, elongated; umbones anterior, eared, the posterior ear wing-like; cartilage contained in one or several grooves; hinge edentulous, or obscurely toothed.

Animal with the mantle-lobes free, their margins fringed; foot small, spinning a byssus; gills two on each side, crescent-shaped, entirely free or united to each other posteriorly, and to the mantle (as in the oyster, and not as in Pecten).

The wing-shells, or pearl-oysters, are natives of tropical and temperate seas; there are no living species in northern latitudes, where fossil forms are very numerous. The family is mostly extinct, and largely represented in palæozoic rocks; there are 120 recent and over 1000 fossil species.

SUBFAMILY *AVICULINÆ.*

Ligament attached to the entire external hinge-margin or placed in a single shallow groove near the beak and spreading over the hinge-area as it extends posteriorly; anterior muscular scar very small.

AVICULA (Klein), Lamarck, 1799.

Etym.—*Avicula*, a little bird.

Syn.—Pteria, Scopoli, 1777. Anonica, Oken, 1815.

Distr.—25 sp. Mexico, South Britain, Mediterranean, India, Pacific; 20 fathoms. Fossil, 300 sp. Lower Silurian—; world-wide. *A. heteroptera*, Lam. (cxxxi, 61). *A. crocea*, Lam. (cxxxi, 62).

Shell obliquely oval, very inequivalve, eared, the posterior ear produced, wing-like; right valve with a byssal sinus beneath the anterior ear; cartilage-pit single, oblique; hinge with one or two small cardinal teeth, and an elongated posterior tooth, often obsolete; posterior muscular impression (adductor and pedal) large, subcentral; anterior (pedal scar) small, umbonal.

Animal oval, flat; mantle-lobes separated throughout, thickened and serrated at the margins; body very small, having on either side a pair of nearly equal large branchiæ; mouth oval, rather large; palpi large, obliquely truncate; byssus large, coarse, sometimes consolidated.

ELECTROMA, Stolicz. Oblique, thin, mostly smooth; inequivalve, the right valve being somewhat flatter; the hinge-line is short, and the posterior wing very short; not separated from the body of the shell. *A. smaragdina*, Reeve.

PSEUDOPTERA, Meek. Shell more or less obliquely subtrigonal or subovate; hinge short, compressed; anterior wing short, not defined; posterior abbreviated, compressed, and nearly or quite without any marginal sinuosity below it; anterior margins sometimes a little sinuous near the middle, but without any byssal sinus under the anterior wing. *Avicula anomala*, Sby. (cxxx, 38). *Pinna fibrosa*, M. and H. Cretaceous.

OXYTOMA, Meek. Shell with nearly the general outline of the typical form, but usually less oblique, and more inequivalve, with the byssal sinus very deeply and sharply cut, close up under the anterior auricle of the right valve. Several sp. Triassic, Jurassic and Cretaceous. *Avicula Munsteri*, Bronn.

MELEAGRINA, Lam., 1799. (Margaritophora, Muhlfeldt. Perlamater, Schum., 1817.) The "pearl-oysters" are less oblique than the other Aviculæ, and their valves are flatter and nearly equal; the posterior pedal impression is blended with that of the great adductor. Animal with mantle-lobes united at one point by the gills, their margins fringed and furnished with a pendent curtain; curtains fringed in the branchial region, plain behind; foot finger-like, grooved; byssus often solid, cylindrical, with an expanded termination; pedal muscles four, posterior large in front of the adductor; adductor composed of two elements; retractors of the mantle forming a series of dots, and a large spot near the adductor; lips simple; palpi truncated; gills equal, crescentic, united behind the foot. Pearl-oysters are found at Madagascar, Ceylon, Swan River, Panama, etc. Manilla is the chief port to which they are taken. There are three principal kinds, which are worth from £2 to £4 per cwt.: 1. The silver-lipped, from the Society Islands, of which about twenty tons are annually imported to Liverpool. 2. The black-lipped, from Manilla, of which thirty tons were imported in 1851. 3. A smaller sort from Panama, 200 tons of which are annually imported; in 1851 a single vessel brought 340 tons.—T. C. ARCHER. These shells afford the "mother-o'-pearl" used for ornamental purposes; and the "oriental" pearls of commerce. Mr. Hope's pearl, said to be the largest known, measures two inches long, four round, and weighs 1800 grains. Pearl-oysters are found in about 12 fathoms water; the fisheries of the Persian Gulf and Ceylon have been celebrated from the time of Pliny. *M. margaritifera*, Linn. (cxxxi, 63).

AUCELLA, Keyserling, 1846. Very inequivalve; left umbo prominent, earless; right valve small and flat, with a deep sinus beneath the small anterior ear. Fossil, 4 sp. Permian—Gault;

Europe. "In *A. cygnipes* we find no trace of prismatic-cellular structure or nacre, but the coarsely corrugated and somewhat tubular structure of the Pectens."—CARPENTER. *A. Mosquiensis*, Keyserl. (cxxx, 35).

PTEROPERNA, Morris and Lycett, 1850.

Distr.—Fossil, 3 sp. Bath Oolite; Britain, France. *P. costulata*, M. and L. (cxxx, 39).

Shell with a long posterior wing; hinge-line bordered by a groove; anterior teeth numerous, minute; posterior one or two, long, nearly parallel with the hinge-margin.

An important external character is the presence of a longitudinal ridge on the outside of the wing.

CASSIANELLA, Beyrich, 1861.

Syn.—Gryphorhynchus and Acinophorus, Meek, 1864.

Distr.—Fossil, 6 sp. Upper Trias—L. Lias; Austria, Bavaria, Himalayas. *C. gryphæata*, Münst. (cxxx, 40, 41).

Shell thick, subhemispherical; right valve flat or concave, the left very gibbous; no defined byssal sinus. Umbones subcentral, hinge-line equaling the greatest length of the shell, in both valves with a wide well-defined cardinal area; ears subequal, not produced. Hinge with several small irregular teeth near the middle. Surface striated.

PSEUDOMONOTIS, Beyrich, 1862.

Syn.—Eumicrotis, Meek, 1864.

Distr.—Devon., Triassic, Jurassic. *P. speluncaria*, Münst. (cxxx, 42).

Suborbicular or roundly oval, the right valve being usually more or less convex, with small, or nearly obsolete, wings and prominent incurved beaks; the left is conspicuously flattened or slightly concave, with barely prominent beaks and with a straight, thickened hinge-line, sometimes provided with a flattened tooth-like projection below, and an oblique ligamental groove posterior to it, corresponding to a similar groove or pit in the other valve; the anterior end has below the beak a narrow deep byssal incision and a small, sometimes almost obsolete, ear above it. Posterior adductor large, subcentral, anterior minute, at the base of the wing; surface usually covered with radiating ribs.

PTERINEA, Goldfuss, 1832.

Distr.—Fossil, 32 sp. Lower Silurian—Carb.; United States, Europe, Australia. *P. lævis*, Goldfuss (cxxx, 43).

Shell thick, rather inequivalve, very oblique and broadly winged; beaks anterior, sinus shallow; hinge-area long, straight, narrow, striated lengthwise; anterior teeth few, radiating; pos-

terior teeth laminar, elongated; anterior (pedal) scar deep posterior (addúctor) impression large, very excentric.

PTERONITES, M'Coy, 1844. Shell thinner, subtriangular, with the teeth less developed. *P. angustatus*, M'Coy.

EOPTERIA, Billings. (?Euchasma, Billings.) Valves equally convex, hinge with an external (?) ligament. *P. typica*, Billings. Lower Silurian; Newfoundland.

ACTINOPTERA, Hall, 1883. Differs from Pterinea in the absence of striated ligamental area, and strong cardinal and lateral teeth; right valve convex. Several sp. Palæozoic; New York. *P. muricata*, Hall.

PTYCHOPTERIA, Hall, 1883. Differs from Actinoptera in the nasute anterior extremity, and large straight wing marked by a strong longitudinal fold. 10 sp. Fossil. Chemung Group; New York. *P. Eugenia*, Hall.

PTERONITELLA, Billings, 1874.

Distr.—3 sp. U. Silurian; Nova Scotia. *P. venusta*, Billings.

Founded on casts showing in front of the beaks several small, anterior cardinal teeth, and close beneath the hinge-line several more or less elongated posterior teeth; there is a strong anterior muscular impression, and the whole structure of the hinge resembles closely that of Cyrtodonta.

HALOBIA, Bronn, 1830.

Distr.—Trias; Hallstadt, Spitzbergen, New Zealand, California, Nevada. *H. rarestriata*, Mojs.

Shell semicircular or semioval, with a straight edentulous hinge-linge and almost central, scarcely prominent beaks; valves rather compressed, equal, radiately ribbed, the ribs placed close to the hinge-line being usually conspicuously thicker than others; wings subequal, rounded at their termination and not emarginated, muscular scars indistinct.

The original species described by Bronn is noted as *H. salinarum*, and is based upon an imperfect specimen, apparently restored to a much oblique and inequilateral form. It has the anterior wing conspicuously inflated along the hinge-margin, and hollow internally.

DAONELLA, Mojsisovics, 1874. Lateral margins rounded into the straight dorsal border; cardinal margin compressed or with an oblique furrow on the anterior side, indicating a slight tendency to form an obscure anterior auricle, defined by the faintest possible indication of a marginal sinus. Barely subgenerically distinct. *D. Lommei*, Wissm. (cxxx, 44).

MONOTIS, Bronn, 1830.

Distr.—Trias; Hallein, Himalayas, Thibet, New Zealand, United States. *M. substriata*, Münst. (cxxx, 45).

Shell subequivalve, obliquely oval, depressed, posteriorly slightly eared, anterior side short; surface radiated; beaks depressed, submedian; cardinal line linear, callous, without teeth, with an inflexion for the passage of the byssus.

POSIDONOMYA, Bronn, 1837.

Etym.—*Poseidôn*, Neptune.

Syn.—Posidonia, Br., 1838 (not König). Aulocomya, Steinmann, 1881.

Distr.—Fossil, 50 sp. Lower Silurian—Trias; United States, Europe. *P. Becheri*, Bronn (cxxx, 46).

Shell thin, equivalve, compressed, earless, concentrically furrowed; hinge-line short and straight, edentulous.

RHYNCHOPTERUS, Meek, 1864.

Distr.—*R. obesus*, Meek (cxxx, 47). Triassic; Nevada.

Shell obliquely elongated, tumid, anteriorly narrow, with a small acute ear, posterior side uniformly and slightly curved, not distinctly winged; hinge-line straight, toothless, slightly thickened; surface covered with concentric striæ only.

This genus greatly resembles one of the mesozoic Aviculæ with smooth surface, differing from them by the absence of the posterior wing. The shell would also appear to have a close resemblance to Myalina.

MONOPTERIA, Meek and Worthen, 1866.

Distr.—Carboniferous; United States. *M. gibbosa*, M. and W. (cxxx, 48).

Obliquely subquadrate, subequivalve, moderately convex, with a large posterior wing, being below the end generally insinuated, anterior wing obsolete or nearly so, impressed below the beak, without a byssal emargination, but apparently slightly gaping within the lunule; muscular scars very faint; hinge edentulous; ligamental area with a few longitudinal furrows.

This has been proposed as a subgenus of Pterinea, but it appears to have no internal hinge-ribs which characterize that genus. The authors speak of certain ligamental furrows extending internally, but they are not shown in the figure of the cast, which in that part appears perfect.

Meek and Worthen also refer to the relation of Monopteria to Hall's Amphicœlia, which, they say, "was proposed as a subgenus under Leptodomus, to which it is not nearly allied. It evidently belongs to the Aviculidæ, near Pterinea, though apparently generically distinct" (see p. 275).

SUBFAMILY *AMBONYCHIINÆ*.

Shell equivalve, beaks sharp, at the anterior end of the long straight hinge; ligament linear, parallel with the hinge-plate; a

byssal opening anterior to the beaks; anterior wing wanting, posterior wing large.

AMBONYCHIA, Hall, 1843.

Syn.—Pimopsis, Hall, 1843.

Distr.—15 sp. Lower Silurian—Carboniferous; United States, Europe, Australia. *A. bellistriata*, Hall (cxxx, 49).

Roundly subquadrangular, equivalve, moderately inflated, with anterior incurved beaks and a posteriorly extended straight hinge-line, anterior side straight, below the beaks slightly insinuated and gaping, posterior truncate; hinge anteriorly below the beaks with a few short oblique, and posteriorly towards the termination of the hinge-line, also with a few subparallel or slightly diverging rib-like teeth; posterior muscular scar large, subcentral, anterior very small or nearly obsolete.

ANOMALODONTA, Miller, 1873. (Megaptera, M. and W., 1866 [not Gray]. Opisthoptera, Meek.) Subtrigonal, subequivalve, posteriorly with a very large pointed wing, obtusely convexly angular from the beak to the inferior narrow end, beaks anterior, terminal, incurved, slightly projecting above the hinge-line, anterior wing probably obsolete; hinge with a few small anterior teeth below the beak, as in Ambonychia; posterior muscular scar large, subcentral, pallial line extending anteriorly up to very near the beak. This form is considered by its authors to be a subgenus of Ambonychia, differing from it by the very strong development of the posterior wing, on which no internal ribs have as yet been observed. *A. Casei*, M. and W. (cxxx, 50).

AMPHICŒLIA, Hall, 1867.

Distr.—3 sp. Palæozoic; U. S. *A. Leidyi*, Hall (cxxx, 33).

Shell (cast) subrhomboidal, with elevated beaks, beneath which appears a large triangular cartilage-pit, and a second smaller pit anterior to it; no teeth have been discovered on the extension of the hinge-line; muscular impressions faint, shell thin.

LUNULACARDIUM, Münster, 1846 (Zittel, 1881).

Distr.—Devonian; Eur. *L. semistriatum*, Münst.

Shell obliquely oval, like Lima, radially sculptured; with a straight, toothless hinge; posteriorly shortly winged; anteriorly excavated, with a deep lunule and narrow byssal opening.

A portion of the species originally referred to this group, appears similar to, perhaps identical with, Chænocardia, Meek and Worthen.

GOSSELETIA, Barrois, 1881.

Distr.—*G. Devonica*, Barrois. Devonian; Spain.

Shell equivalve, inequilateral, gibbous, oblique, posteriorly

obtusely winged, beaks prominent, turned anteriorly, surface smooth, with growth-lines; the hinge shows a ridge directed posteriorly, on each side of which is the ligamental area, covered with parallel grooves; these grooves are subparallel with the two margins of the shell, but whilst they are regular and straight on the posterior side, they are curved anteriorly; cardinal teeth three, the anterior one usually bifid; pallial impressions unknown.

MYALINADONTA, Œhlert, 1882. Teeth differently disposed, the form is flattened and the cardinal margin is perpendicular to the axis of the shell.

MYTILARCA, Hall, 1869.

Distr.—13 sp. Fossil; Chemung Group, N. Y.; Germany. *M. Chemungensis*, Conr. (cxxx, 51).

Shell equivalve, mytiliform; beaks terminal and hinge-line straight; anterior end of hinge-plate with one to three rather strong oblique teeth in each valve, with corresponding cavities; posterior end with from two to four often obscure, parallel contiguous tooth-like ridges, the marginal one parallel with the posterior border of the valve, the others shorter and divergent; anterior border nearly straight, somewhat sinuate on the margin, apparently for the accommodation of byssal threads; posterior border usually subparallel with the anterior, while the basal margin is generally abruptly rounded like that of Mytilus; muscular markings very like Mytilus; surface of valves often obscurely radiately striate.

PLETHOMYTILUS, Hall, 1883.

Distr.—Palæozoic; New York. *Inoceramus mytilimerus*, Conrad.

Shell mytiloid, gibbous, with a finely striated ligamental area; hinge edentulous so far as observed. Differs from Mytilarca in its erect form, shorter transverse hinge-line, absence of cardinal and lateral teeth, and non-truncate anterior side.

LIMOPTERA, Hall, 1869.

Distr.—5 sp. Fossil. Upper Helderberg and Hamilton Groups; New York, Kentucky. *L. pauperata*, Hall.

Shell large, inequilateral, inequivalve, the right valve smaller; ligamental area large, longitudinally striate, and extending to the extremity of the wings; anterior margins sinuated, forming an elongated byssal opening; hinge edentulous? anterior muscular impression within the umbones, very small and deep; posterior one large, a little behind the middle of the shell, and nearer the hinge than the base; pallial line simple, formed of a series of small, deep pits (or, as seen in the casts, of a series of small nodes).

GLYPTODESMA, Hall, 1883.

Type, *G. erectum*, Conr. Hamilton Group; N. Y.

Ligamental area striated, continuous; hinge with two strong lateral teeth, and numerous irregular transverse plications along the cardinal margin. In form like Actinodesma, but without the prominent diverging teeth of that group.

ECTENODESMA, Hall, 1883. Resembles Glyptodesma in outline, except that the anterior wing is more produced, and both wings more acute at their extremities; surface ornamented with rays. *G. birostratum*, Hall. Chemung Group; New York.

LEIOPTERIA, Hall, 1883.

Distr.—7 sp. Fossil. Hamilton Group; N. Y. *L. Dekayi*, Hall.

Aviculoid, resembling Actinoptera in form; anterior extremity auriculate; wing large, extremity produced; surface without prominent rays.

LEPTODESMA, Hall, 1883. In its prevailing forms like Leiopteria, except that the anterior end is nasute and acute, instead of auriculate and rounded; hinge-line narrow. 12 sp. Chemung Group; New York. *L. potens*, Hall.

SUBFAMILY *PERNINÆ.*

Cartilage situated in a number of transverse marginal grooves of the hinge-line. Anterior muscular scar generally very small.

PERNA, Bruguière, 1792.

Etym.—*Perna*, a shell-fish (resembling a gammon). (Pliny.)

Syn.—Melina, Retz, 1788. Isognomon, Klein, 1753. Pedalion, Solander. Hippochæta, Sangiovanni.

Distr.—18 sp. Tropical seas; West Indies—India—West America. Fossil, 30 sp. Trias—; United States, Chili, Europe. *P. ephippium*, Linn. (cxxxi, 64). *P. Mulleti*, d'Orb. (cxxx, 52).

Shell nearly equivalve, compressed, subquadrate; area wide, cartilage-pits numerous, elongated, close-set; right valve with a byssal sinus; muscular impression double.

The Pernas vary in form like the Aviculæ; some are very oblique, some very inequivalve, and many fossil species have the posterior side produced and wing-like. In some Tertiary Pernas the pearly layer is an inch thick.

PULVINITES, Defrance, 1824. (Hypotrema, d'Orb., 1853.) Shell oblong, inequivalve; right valve flat or concave, with a round byssal foramen near the hinge; left valve convex, with a muscular impression near the umbo; hinge-margin broad, curved, with about twelve close-set transverse cartilage-grooves. *P. Rupellensis* (=? *Pulvinites Adansoni*, Defrance, 1826 [cxxx, 53]). Coral-rag, Rochelle.

CRENATULA, Lamarck, 1802.

Syn.—Dalacia, Gray, 1848.

Distr.—8 sp. N. Africa, Red Sea, China—in sponges. Fossil, 4 sp. Jurassic. *C. viridis*, Lam. (cxxxi, 65).

Shell thin, oblong, compressed, byssal sinus obsolete; cartilage-pits shallow, crescent-shaped.

? LEPROCONCHA, Giebel, 1856.

A small, roundish shell, with the lamellar structure of an Ostrea, umbones nearly central, as in Brachiopoda, outer surface tubercular, hinge-area with three to four ligamental (?) grooves.

The above name has been proposed for a small Triassic shell which Giebel says comes near to Plicatula or Pulvinites. If the hinge-grooves are ligamental, as they are supposed to be, the classification of this genus would be near Pulvinites; but better material must be examined, in order to define the characters of both these problematic genera.

PERNOSTREA, Munier-Chalmas, 1864.

Distr.—6 sp. Jurassic; Europe. *P. Bachelieri*, M.-C. (cxxx, 54).

Shell rounded or oval, solid, more or less tumid, inequivalve, the left valve being in adult specimens attached; structure lamellar, resembling that of Perna; beaks usually indistinct, hinge-area broad, or with age becomes more or less reduced in extent, with numerous (4–8) transverse ligamental grooves or pits, as in Perna; muscular impression rather small, subcentral, ovately rounded, in the right valve. This genus forms a connecting link between Perna and Ostrea, differing from the former especially by its sessile habitat, absence of a byssal sinus and strongly excavated muscular scar, from the latter by the presence of separate ligamental grooves. Externally Pernostrea is barely distinguishable from Ostrea.

INOCERAMUS, Sowerby, 1814.

Etym.—*Is* (inos), fibre; *keramos*, shell.

Syn.—Mytiloides, Brongt.

Distr.—Fossil, 75 sp. ? Silurian, Trias—Cretaceous; South America, United States, Europe, Algeria, Thibet. *I. concentricus*, Sowb. (cxxx, 55).

Shell inequivalve, ventricose, radiately or concentrically furrowed, umbones prominent; hinge-line straight, elongated; cartilage-pits transverse, numerous, close-set.

This genus differs from Perna chiefly in form. *I. involutus* has the left valve spiral, the right opercular. *I. Cuvieri* attains the length of a yard. Large flat fragments are common both in the chalk and flints, and are often perforated by Cliona.

Hemispherical pearls have been found developed from their inner surface, and spherical pearls of the same prismatic-cellular structure occur detached, in the chalk.—WETHERELL. The Inocerami of the gault are nacreous.

CATILLUS, Brongniart, 1822. (Haploscapha, Conr.) Shell flattened or ventricose, elongated, cordiform or suborbicular, subequivalve, inequilateral; hinge-line nearly straight, its margin with a short series of small cavities, gradually enlarging; shell fibrous. *I. Lamarckii*, Brongn. (cxxx, 56). Cretaceous.

ACTINOCERAMUS, Meek, 1864. Proposed for a small group of Inocerami of the type of *I. sulcatus*, Park. (cxxx, 57). They have a rather short and sometimes oblique hinge-line, the left valve is often slightly more globose than the right, and both are distinguished from other similar forms by the presence of radiating ribs. The fibrous layer appears to be often thinner in Actinoceramus than in most of the concentrically sulcated Inocerami.

VOLVICERAMUS, Stoliczka. Type, *I. involutus*, Sow. (cxxx, 58), which has the left valve strongly involute like a nautilus or somewhat resembling a Gryphæa, while the right valve is very much smaller, flattened, slightly tumid at the apex, resembling an operculum; the hinge-line is curved, conformed to the ovately rounded aperture of the left valve, thickened and provided with numerous ligamental pits, as in other typical species of the genus.

ANOPÆA, Eichwald, 1861.

Distr.—3 sp. Cretaceous; Russia.

Equivalve, inequilateral, elongated, with the shorter anterior part narrower, beaks close together, with a deep circumscribed lunule in front of them; ligament situated in a number of roundish pits in the straight cardinal margin, which has a rib-like tooth in the left valve below the beak, extending anteriorly for a short distance. Principally differs from Inoceramus by the presence of a deep lunule and by the internal hinge-rib (in the left valve).

GERVILLIA, Defrance.

Etym.—Dedicated to M. Gerville, a French naturalist.

Distr.—Fossil, 37 sp. Carb.—Chalk; Europe. *G. anceps*, Desh. (cxxxii, 90).

Shell like Avicula; elongated; anterior ear small, posterior wing-like; area long and flat, cartilage-pits several, wide apart; hinge-teeth obscure, diverging posteriorly.

BAKEWELLIA, King. Shell small, inequivalve, cartilage-pits 2–5; hinge with anterior and posterior teeth; anterior muscular impression and pallial line distinct. Fossil, 5 sp. Permian; Britain, Germany, Russia, U. S. *G. antiqua*, Münst. (cxxx, 59, 60).

a depression in the other valve; lunular area long, slightly gaping, with simple thickened margins, posterior side shorter, evenly rounded; muscular scar small, subcentral, semilunar, deeply impressed; surface of shell concentrically lamellar.

CHALMASIA, Stoliczka, 1870.

Distr.—Several sp. Cretaceous; Europe. *C. Turonensis*, Duj.

Irregularly oblong, longer than high, with prominent obtuse beaks, subequivalve, the valves being slightly convex, ligamental groove large, moderately excavated, margin in front of the beaks with several irregular incisions, or internal grooves, similar to those of Eligmus, muscular scar subcentral, elongated, and strongly thickened.

Munier-Chalmas refers the type species to Vulsella, but in no recent or tertiary species of that genus do any incisions or plications occur in front of the beaks, nor is the muscular scar equally strong in any of them. The shell differs from Eligmus, merely by its more compressed form and more centrally placed muscular scar and by its thicker shell; it shows greater affinity to Pedum, which has, however, only one incision before the beak, and the ligamental pit strongly produced internally.

ELIGMUS, E. Deslongchamps, 1856.

Etym.—λιγμός, a sinuosity, in allusion to the sinuosities of the borders of the post-apical opening.

Distr.—3 sp. Inferior Oolite, and Great Oolite; Maine-et-Loire, Calvados, Galicia. *E. polytypus*, Desl. (cxxxii, 85–87).

Shell free, or perhaps attached by a byssus, nearly equivalve, inequilateral; ovate or cylindrical, more or less compressed; anterior extremity inflated, and shorter than the attenuated posterior one. Test rather thick, foliaceous. Umbones inflated, slightly depressed or flattened, diverging and directed backwards. Valves closed at both extremities, with an unsymmetrical (byssal?) sinus behind the umbones; ornamented by oblique, radiating carinated ribs; hinge short, straight, edentulous; ligamental area triangular, with a superficial pit; muscular scar single, situated on the free end of a spoon-shaped process, which originates from beneath the umbonal cavity; pallial line wanting.

The internal process of Eligmus has no analogy with that of the Myæ and Anatinæ, which in them supports the cartilage, and is an internal prolongation of the hinge; whilst that of Eligmus gives attachment to the adductor muscle, and arises from beneath the hinge. Eligmus is related through *Chalmasia Turonensis*, Dujardin, to Vulsella; the test, however, is not fibrous, and M. Munier supposes that the internal nacreous layer has been destroyed by fossilization.

Family PINNIDÆ.

Pinna, Linn, 1758.

Etym.—*Pinna*, a fin or wing.

Distr.—30 sp. U. S., Britain, Mediterranean, Australia, Pacific, Panama. Fossil, 60 sp. Devonian—. Increasing to the present time. U. S., Europe, South India. *P. rudis*, Linn. (cxxxi, 67).

Shell equivalve, wedge-shaped; umbones quite anterior; posterior side truncated and gaping; ligamental groove linear, elongated; hinge edentulous; anterior adductor scar apical, posterior subcentral, large, ill-defined; pedal scar in front of posterior adductor.

Animal with the mantle doubly fringed; foot elongated, grooved, spinning a powerful byssus, attached by large triple muscles to the centre of each valve; adductors both large; palpi elongated; gills long.

The shell of the Pinna attains a length of two feet; when young it is thin, brittle, and translucent, consisting almost entirely of prismatic cell-layers; the pearly lining is thin, divided, and extends less than half-way from the beak. Some fossil Pinnas crumble under the touch into their component fibres. The living species range from extreme low-water to sixty fathoms; they are moored vertically, and often nearly buried in sand, with knife-like edges erect. The byssus has sometimes been mixed with silk, spun, and knitted into gloves, etc.

A little crab which nestles in the mantle and gills of the Pinna was anciently believed to have formed an alliance with the blind shell-fish, and received the name of Pinna-guardian (Pinnoteres) from Aristotle; similar species infest the Mussels and Anomiæ of the British coast.

Atrina, Gray, 1840. Shell irregular, valves connate, as though soldered together on the dorsal margin. *P. saccata*, Linn. (cxxxi, 68).

Palæopinna, Hall, 1883. Shell gaping in front; surface marked by fine radiating lines. More convex and with finer rays than in Pinna. 2 sp. Palæozoic; N. Y. *P. recurva*, Hall.

Trichites, Defrance, 1828. (Pinnigena, Agassiz, 1847.) Shell thick, inequivalve, somewhat irregular, margins undulated. Fossil, 5 sp. Oolitic strata of England and France. *P. undatus*, Lycett (cxxxii, 88). Fragments an inch or more in thickness are common in the Cotteswold-hills; full-grown individuals are supposed to have measured a yard across.

Aviculopinna, Meek, 1864. Very elongately subtrigonal, equivalve, with slightly indicated subterminal beaks, the shell being somewhat produced in front of them, posteriorly gaping;

hinge-line very long, edentulous. *Avic. prisca*, Münst. (cxxxii, 89), from permian rocks.

BRYOPHILA, Carpenter, 1864.

Distr.—*B. setosa*, Carp. On algæ, at Cape St. Lucas, L. California.

Shell like a minute Pinna, with pointed beaks; upper margin straight, with a strong internal ligament, anteriorly at the byssal sinus somewhat insinuated, ventrally and posteriorly rounded and gaping; posterior muscular scar subcentral, indistinct.

The animal is stated to be viviparous; and in form "like a minute Pinna, or a transverse Margaritophora without ears, or a Perna without pits." Its length is only 0·13 inch and the width 0·2 inch, but it is said to be adult. The structure of the shell agrees with that of Pinna, being fibrous externally, nacreous internally.

SUBORDER *MONOMYARIA*.

Shell with a single subcentral or subposterior muscular impression.

(*Pectinacea.*)

FAMILY SPONDYLIDÆ.

Shell inequivalve, right valve largest, attached at the beak; cartilage internal, in a median pit; hinge-teeth two in each valve, sometimes without teeth; outer surface with radiating ribs, often spiniferous.

PLICATULA, Lamarck, 1801.

Etym.—*Plicatus*, plaited.

Distr.—9 sp. W. Indies, India, Philippines, Australia, West America. Fossil, 106 sp. Trias—; United States, Europe, Algeria, India. *P. Mantelli*, Lea, Alabama, has the valves eared. *P. ramosa*, Linn. (cxxxi, 69).

Shell irregular, attached by the umbo of the right valve; valves smooth or plaited; hinge-area obscure; cartilage quite internal; hinge-teeth two in each valve; adductor scar simple.

Animal resembles Spondylus.

HARPAX (Parkinson, 1811), Deslongchamps, 1858. Hinge of attached valve consisting of a flattened triangular plate, traversed by a central more or less perpendicular ligamental furrow, exterior to which are slightly marked diverging sulci to receive the elevated borders of the ligamental groove in the other valve; the outer borders of the plate form lengthened and elevated dental processes. Hinge-plate of free valve traversed mesially by the ligamental groove, the borders to which are elevated and but slightly diverging; exterior to these are

strongly impressed grooves to receive the dental processes of the other valve. Fossil, 16 sp. Lias and Lower Oolite; France and England.

SPONDYLUS (Pliny), Linn.

Thorny-oyster.

Syn.—Dianchora, Sby., 1814. Podopsis, Lam., 1819. Pachytes, Defr., 1825. (All based upon casts or imperfect specimens.—DESHAYES.)

Distr.—68 sp. West Indies, Canaries, Mediterranean, India, Torres Straits, Pacific, West America; 105 fathoms. Fossil, 80 sp. Carb—; Europe, United States, India. *S. regius*, Linn. (cxxxi, 71, 73). *S. Americanus*, Lam. (cxxxi, 72).

Shell irregular, attached by the right valve, radiately ribbed, spiny or foliaceous; umbones remote, eared; lower valve with a triangular hinge-area, cartilage in a central groove, nearly or quite covered; hinge of two curved interlocking teeth in each valve; adductor impression double.

Animal with the mantle open and gills separate, as in Pecten; lips foliaceous, palpi short; foot small, cylindrical, truncated.

In aged specimens the circular portion of the muscular scar exhibits dendritic vascular markings. The lower valve is always most spiny and least colored; in some species (like *S. imperialis*) the shell is scarcely, if at all, attached by its beak or spines. The inner shell-layer is very distinct from the outer, and always wanting in fossil specimens from calcareous rocks, then called Dianchoræ. Specimens from the Miocene of St. Domingo, which have lost this layer, contain a loose mould of the original interior. Water-cavities are common in the inner layer, the border of the mantle having deposited shell more rapidly than the umbonal portion.

PEDUM, Brug., 1792.

Distr.—Red Sea, Indian Ocean, Mauritius, Chinese Seas. *P. Spondyloideum*, Gmel. (cxxxi, 70).

Shell thin, smooth, compressed, attached by a byssus passing through a deep notch in the right valve. Inhabits coral-reefs, where it is found half-embedded.

TERQUEMIA, Tate, 1867.

Etym.—Dedicated to M. O. Terquem, an eminent palæontologist.

Syn.—Carpenteria, E. Deslongchamps, 1858 (*non* Gray, 1856).

Distr.—Fossil, 5 sp. Trias—Lias; France, Germany, Great Britain. *T. Heberti*, Terquem.

Shell inequivalve, subequilateral, attached by the umbonal portion of the right valve; the left valve slightly concave,

smooth, and ornamented posteriorly, as also the free portion of the right valve, by concentric plications or radiating ribs. Hinge-area triangular, transverse, striated in the same direction, edentulous, sometimes produced in the middle line; ligamental furrow median, longitudinal, straight, rather narrow. Muscular scar near the posterior margin; pallial line wanting. Externally the shells of this genus resemble those of Hinnites and Ostrea.

Family LIMIDÆ.

Shell eared, white, gaping at the sides; hinge edentulous, with a central, triangular cartilage-pit.

The large development of the internal thin layer of the mantle, forming an open bag, appears to be destined for hatching the eggs, and is no doubt also an important organ for retaining water while swimming.

Mostly extinct, from palæozoic. Nearly 300 fossil species, but few of them in the new world.

Lima, Bruguière, 1792.

Etym.—*Lima*, a file. *Syn.*—Radula, Klein.

Distr.—20 sp. Norway, Britain, W. Indies, Canaries, India, Australia; 1–150 fms. The largest living species (*L. excavata*, Chemn.) is found on the coast of Norway. Fossil, 300 sp. Carb., Trias—; United States, Europe, India. *L. squamosa*, Lam. (cxxxii, 91, 92).

Shell equivalve, compressed, obliquely oval; anterior side straight, gaping, posterior rounded, usually close; umbones apart, eared; valves white, smooth, punctate-striate, or radiately ribbed and imbricated; there is usually a thin, brownish epidermis; hinge-area triangular, cartilage-pit central; adductor impression lateral, large, double; pedal scars two, small.

Animal: mantle-margins separate, inner pendent, fringed with long tentacular filaments, ocelli inconspicuous; foot finger-like, grooved; lips with tentacular filaments, palpi small, striated inside; gills equal on each side, distinct.

The shell is always white: its outer layer consists of coarsely plicated membranous lamellæ; the inner layer is perforated by minute tubuli, forming a complete network.—Carpenter.

"The Lima moves or rather darts through the water like a scallop, but in a contrary posture. The hinder instead of the ventral end is in front, so that the mode of its progression may be compared to that of a fish swimming tail foremost. Some species construct dwelling-places called 'nests' out of fragments of shell, nullipores, gravel and other material, which they ingeniously fasten together by their byssal threads and attach to the roots of large sea-weeds. Several young ones often occupy

the same nest or case; but when they become adult each individual has a house of its own. This remarkable construction is funnel-shaped, with the larger end contracted, and sufficiently wide to admit of the Lima moving freely up and down, but not turning around in it. Here it lives, secure from prowling fish and crabs. The case is lined inside with a closely-woven net of byssal threads, plastered over with slime or excrement. This smooth and soft lining contains a quantity of Diatom-cells, and yields a rich harvest to those who collect these exquisite organisms for microscopic examination. When the Lima is first taken out of its case and put into a basin of sea-water, it is exceedingly active and restless, or else gracefully careering about, with its long and thick fringe of filaments trailing behind it. In the course of a few minutes it seems to get tired or reconciled to its prison; and it then lies on its back, the valves of the shell expanded, and reposes on its own soft, luxurious cushion. The filaments at first curl and entwine round one another, a perfect nest of snakes, but afterwards they are withdrawn and become contracted, a circular inner row, like a coronet, surrounds the slowly flapping gills; and the outer rows fold over on each side and form a sort of chevaux de frise. Dr. Landsborough supposed that these filaments were useful to the Lima in catching its prey. He observed that they were very easily broken off, and that they seemed to live many hours after being detached from the body, wriggling about like so many worms. A remarkable peculiarity of Lima consists in the tenacious grasp of its tentacles; sometimes when my finger touched the animal, it was rapidly seized by the tentacles, as by those of an Actinia, and so firmly that I have dragged the Lima round the tank. It seldom let go its hold till the tentacles were torn away, or (as I believe) voluntarily thrown off by the animal. The tentacles so detached still adhere closely to the object they have grasped, their free ends twisting about as if conscious of life, and they are with difficulty taken off."—Dr. J. Gwyn Jeffreys, *Brit. Conch.*

LIMATULA, S. Wood, 1839. Valves equilateral, radial ribs only developed in the middle of the shell. 8 sp. Greenland—Britain. Fossil. Miocene—; Europe. *L. bullata*, Born (cxxxii, 93).

LIMÆA, Bronn, 1831. Hinge minutely toothed. *L. strigillata*, Brocchi. Fossil, 4 sp. Lias—Pliocene. The recent *Limæa? Sarsii*, Lovén (cxxxii, 94), Norway (= *L. crassa* of the Ægean?), has the mantle-border plain. Some of the larger recent species have obscure lateral teeth.

CTENOIDES, Klein, 1753. Shell thin, subequilateral; sculpture radiating from the longitudinal centre-line of the valve. *L. scabra*, Born (cxxxii, 95).

MANTELLUM, Bolten, 1798. Shell thin, ventricose, oblique,

strongly gaping anteriorly; cardinal line oblique. *L. inflata*, Chemn. (cxxxii, 96).

ACESTA, H. and A. Adams, 1855. Shell thin, inequilateral, ventricose, a little gaping; surface covered by radiating striæ, and concentric growth-lines; ligament-pit oblong, lateral. *L. excavata*, Chemn. (cxxxii, 97).

PLAGIOSTOMA, Sow., 1812. Must be reserved for the species of the type of the Liassic *Pl. gigantea*, for which it was originally proposed. It is a very well-marked group of fossil, especially mesozoic, Limæ, of a semiovate or subtriangular shape, with nearly smooth or finely radiately striated surface, the striæ being generally only conspicuous at the sides of the valves, but nearly obsolete in the middle; the ears are thick and unequal, the anterior being smaller, and the cartilage-pit is oblique and triangular, generally very deep. *L. Cardiiformis*, Sowb. (cxxxii, 98).

CTENOSTREON, Eichw., 1867. Subequivalve, with strong radiating ribs, the large anterior margin above, or at the side with a distinct byssal sinus. *Ct. distans*, Eichw. Neocomian of Russia. This is another well-marked group of generally large and strongly ribbed Limæ, the shell of which is often irregular, like that of some Hinnites; when adult, it is characterized by the presence of a deep insinuation in the anterior ear for the byssus, but in young shells this insinuation is hardly more developed than in other allied forms. *Lima proboscidea* of Sowerby, from Jurassic deposits, is another species of the subgenus, and there are a few other mesozoic forms which may be referred to it.

FAMILY PECTINIDÆ.

Shell free or adherent, inequivalve, regular or irregular, auricled; internal ligament inserted in a cardinal pit under the beaks—it is sometimes externally prolonged, in the adherent species, in a notch between the beaks.

No siphons; foot small and cylindrical; mantle open, its lobes tentaculated.

PECTEN, O. F. Müller.

Etym.—*Pecten*, a comb. Scallop.

Syn.—Argus, Poli. Discites, Schl. Amussium, Muhlfeldt.

Distr.—200 sp. World-wide; Nova-Zembla—Cape Horn; 200 fathoms. Fossil, 450 sp. (including Avieulopecten). Worldwide; Devonian—. *P. purpuratus*, Lam. (cxxxiii, 14). *P. pallium*, Linn. (cxxxiii, 13).

Shell suborbicular, regular, resting on the right valve, usually ornamented with radiating ribs; beaks approximate, eared; anterior ears most prominent; posterior side a little oblique; right valve most convex, with a notch below the front ear; hinge-

margins straight, united by a narrow ligament; cartilage internal, in a central pit; adductor impression double, obscure; pedal impression only in the left valve, or obsolete.

Animal with the mantle quite open, its margins double, the inner pendent like a curtain, finely fringed; at its base a row of conspicuous round black eyes (ocelli) surrounded by tentacular filaments; gills exceedingly delicate, crescent-shaped, quite disconnected posteriorly, having separate excurrent canals; lips foliaceous; palpi truncated, plain outside, striated within; foot finger-like, grooved, byssiferous in the young.

The scallop (*P. maximus*) and "quin" (*P. opercularis*) are, in Europe, esteemed delicacies; the latter covers extensive banks, especially on the north and west of Ireland, in 15–25 fathoms water. The scallop ranges from 3–40 fathoms; its body is bright orange, or scarlet, the mantle fawn-color, marbled with brown; the shell is used for "scalloping" oysters; formerly it it was employed as a drinking cup, and celebrated as such in Ossian's "hall of shells." An allied species has received the name of "St. James's shell" (*P. Jacobæus*); it was worn by pilgrims to the Holy Land, and became the badge of several orders of knighthood.

Most of the Pectens spin a byssus when young, and some, like *P. varius*, do so habitually; *P. niveus* moors itself to the fronds of the tangle (Laminaria).

The Rev. D. Landsborough observed the fry of *P. opercularis*, when less than the size of a sixpence, swimming in a pool of sea water left by the ebbing of the tide. "Their motion was rapid and zigzag; they seemed, by the sudden opening and closing of their valves, to have the power of darting like an arrow through the water. One jerk carried them some yards, and then by another sudden jerk they were off in a moment on a different tack." European epicures regard the large species as dainty articles of food, and the American *P. irradians*, of late years, is increasingly sold in our markets.

The shell of Pecten and the succeeding genera consists almost exclusively of membranous laminæ, coarsely or finely corrugated. It is composed of two very distinct layers, differing in color (and also in texture and destructibility), but having essentially the same structure. Traces of cellularity are sometimes discoverable on the external surface; *P. nobilis* has a distinct prismatic-cellular layer externally.—CARPENTER.

PALLIUM, Schum., 1817. (Dentipecten, Ruppell, 1835. Decadopecten, Sowb., 1839.) Hinge obscurely toothed. *P. plica*, Linn. (cxxxiii, 15).

CHLAMYS, Bolten, 1798. (Argus, Argoderma, Poli.) Shell subequivalve, with radiating striæ or ribs. *P. islandicus*, Chemn. (cxxxiii, 16).

LIROPECTEN, Con., 1867. (Lyropecten, Conrad.) Somewhat inequivalve, with moderately developed unequal ears, valves ornamented with strong nodulose and striated ribs, near the umbones always somewhat irregularly gibbose; hinge with a few oblique teeth on each side of the ligamental fosset. Type, *P. nodosus*, Linn. (cxxxiii, 17). There are a few tertiary species from North America referred to this subgenus, and it is very likely also that species, like the cretaceous *P. septemplicatus*, Nilss., and a few others, belong to it.

CAMPTONECTES, Agassiz, 1864. (Eburneopecten, Agass., 1865.) Valves subequal, moderately flattened, ovate or subovate, with well-developed, or rather small, unequal ears, the anterior of the right valve with a byssal sinus, surface marked with fine radiating, curved striæ, separated by punctated grooves. Type, *P. lens*, Sow. Forms belonging to this subgenus only occur in the mesozoic strata. The two valves often are unequally strongly striated.

PSEUDAMUSSIUM, Klein, 1753. (Syncyclonema, Meek, 1864.) Shell fan-shaped, thin, subequivalve; smooth, or striate, or with a few large, rounded ribs. *P. pseudamussium*, Lam. (cxxxiii, 18).

PLEURONECTIA, Swainson, 1840. (Amussium, Klein, 1753.) Shell nearly orbicular, depressed, subequivalve, with very small ears; smooth outside, with radiating ribs inside. Large species, with the peculiarity that one valve is highly colored, the other white. The group is almost sufficiently distinct from Pecten to merit the generic position given it by several systematists. *P. Japonicus*, Gmel. (cxxxiii, 19).

PSEUDOPECTEN, Bayle, 1879. Lias; Europe. *P. æquivalvis*, Lam.

VOLA, Klein, 1753. (Janira, Schum., 1817.) Lower valve convex, with produced large beaks, upper valve plane or slightly concave, and frequently smaller than the lower one. *P. dentatus*, Sowb. (cxxxiii, 20). *P. atavus*, d'Orb. (cxxxii, 99).

NEITHEA, Drouet, 1824. Shell inequivalve, like Vola, but with obscure cardinal teeth on the sides of the cartilage-pit, and tooth-like folds on the wings. Fossil only. *P. æquicostatus*, Lam. (cxxxii, 100, 1).

HEMIPECTEN, Adams and Reeves, 1848.

Distr.—1 sp. Sooloo Archipelago. Fossil; Jurassic. *H. Forbesianus*, A. and R. (cxxxiii, 21).

Shell inequivalve, irregular, more or less transparent; upper valve auricled, with a slit below the ear, with denticulated margin; hinge toothless; ligament marginal, in a small central pit.

H. Forbesianus, Ad. and Reeve, is the only recent species known. It appears to adhere temporarily by the right flattened valve to submarine objects; its thin hyaline structure is

very characteristic, and so is also the small marginal cartilage-pit.

HINNITES, Defrance, 1821.

Distr.—4 sp. Europe, California, etc. Fossil; Triassic—. *H. sinuosus*, Lam. (cxxxiii, 22, 23).

Shell oval, irregular, inequivalve, subequilateral, close, adhering by the right valve; eared irregularly; hinge without teeth; ligament thick, in a deep, narrow pit.

Differs from Pecten in its irregular growth, and in being adherent.

AVICULOPECTEN, M'Coy, 1852.

Syn.—? Aphania, de Koninck.

Distr.—Fossil. Devonian—Carb.; Spitzbergen—Australia, N. America. *A. granosus*, Sowb. (cxxxii, 5).

Shell inequivalve, suborbicular, eared; hinge-areas flat, with several long, narrow cartilage-furrows, slightly oblique on each side of the umbones; right valve with a deep and narrow byssal sinus beneath the anterior ear; adductor impression large, simple, subcentral; pedal scar small and deep, beneath the umbo.

Aviculopecten does not possess the prismatic structure of the Aviculidæ, but the peculiar corrugated tubular structure of the Pectinidæ (Meek). It bears the same relations to existing Pectens as Pterinea does to existing Aviculas.

PTERINOPECTEN, Hall, 1883. Hinge-line long; wings not well-defined, being simple expansions or extensions of the upper lateral margins to the hinge-line. 5 sp. Hamilton and Chemung Groups; New York. *A. undosus*, Hall.

EUCHONDRIA, Meek, 1874. Uncharacterized. Type, *Aviculopecten neglectus*, M. and W. (cxxxii, 7, 8). Carboniferous; Ills.

LYRIOPECTEN, Hall, 1883. Differs from Aviculopecten in the short hinge-line and very small anterior wing; surface usually ornamented with strong rays. 5 sp. Chemung and Hamilton Groups; New York. *A. magnificus*, Hall.

PERNOPECTEN, Winchell, 1865.

Etym.—*Perna* and *Pecten*, from a combination of some of the characters of the two genera. *Syn.*—Entolium, Meek, 1865.

Distr.—Fossil, 7 sp. Carboniferous; Michigan, Belgium, Nassau. *P. glaber*, Hall (cxxxii, 6). Probably others referred to Avicula, Pterinea, and more especially to Aviculopecten, Amussium and Pecten.

Shell subequivalve, inequilateral, auriculated; hinge-line straight, with a central triangular cartilage-pit and a transverse plate, with smaller lateral cartilage-pits diminishing in size and depth from the centre outwards.

Pernopecten agrees with Amussium in its subsymmetrical ears, cardinal cartilage-pit, and in the absence of radiating ridges, but differs in its straight hinge-line and lateral cartilage-pits. Entolium, Meek, is founded on a Jurassic species from California, *P. aurarium*, Meek.

CRENIPECTEN, Hall, 1883. Like Aviculopecten in form; hinge furnished with a series of small cartilage-pits throughout its entire length. 12 sp. Chemung Group; N. Y. *P. Leon*, Hall.

STREBLOPTERIA, M'Coy, 1851.

Distr.—Carboniferous. *S. lævigata*, M'Coy (cxxxii, 9).

Shell ovate or rounded, obliquely extended towards the anterior side; posterior wing broad, undefined, nearly rectangular, extending nearly as far as the posterior margin of the shell; anterior ear small, deeply defined; surface smooth or radiatingly ridged; one large, faintly marked muscular impression a little behind the middle; one short, narrow tooth, slightly diverging from the hinge-line, on the posterior side of the beaks; ligament confined to a narrow, simple facet on the hinge-margin.

These shells differ from the short-winged Aviculæ, to which they are most allied, by the obliquity of the body of the shell being towards the anterior instead of the posterior side.

(*Anomiacea.*)

FAMILY ANOMIIDÆ.

Shell thin, perlaceous, with a deep notch or hole in the inferior valve near the beaks, for the passage of a byssal plug, by which the shell is attached.

Mouth with narrow, plain lips, confluent with the gills, palps obsolete; mantle quite open, except at the hinge, with a double pendent margin, fringed with short cirri; no ocelli; gills two on each side, unsymmetrical, united posteriorly, and suspended by two falciform membranes; outer gill-lamina furnished with a broad reflexed margin; foot small, cylindrical, expanded at the end and grooved. Sexes distinct. Byssus large, laminar, passing through a nearly complete foramen in the right mantle-lobe, and attached by a powerful muscle to the centre of the left valve. The *Anomia ephippium* is used in France as an article of food.

ANOMIA, Linn., 1767.

Etym.—*Anomios*, unequal.

Syn.—Fenestrella, Bolten. Cepa, Humph.

Distr.—20 sp. North America, Britain, Black Sea, India, Australia, West America, Icy Sea. Low-water—100 fathoms. Fossil, 36 sp. Oolite—; Chili, United States, Europe, India. *A. ephippium*, Linn. (cxxxiii, 24).

Shell suborbicular, very variable, translucent, and slightly pearly within, attached by a plug passing through a hole or notch in the right valve; upper valve convex, smooth, lamellar or striated; interior with a submarginal cartilage-pit, and four muscular impressions, three subcentral, and one in front of the cartilage; lower valve concave, with a deep, rounded notch in front of the cartilage-process; disk with a single (adductor) impression.

Animal with the mantle open, its margins with a short double fringe; lips membranous, elongated; palpi fixed, striated on both sides; gills two on each side, united posteriorly, the outer laminæ incomplete and free; foot small, cylindrical, subsidiary to a lamellar and more or less calcified byssal plug, attached to the upper valve by three muscles; adductor muscle behind the byssal muscles, small, composed of two elements; sexes distinct; ovary extending into the substance of the lower mantle-lobe.

"There is no relationship of affinity between Anomia and Terebratula, but only a resemblance through formal analogy; the parts which seem identical are not homologous."—FORBES.

The Anomiæ are found attached to oysters and other shells, and frequently acquire the form of the surfaces with which their growing margins are in contact.

PATRO, Gray, 1849. Shell suborbicular; two upper scars small, the lower one large. *A. elyros*, Gray (cxxxiiii, 25).

ÆNIGMA, Koch, 1845. Shell oblong, transverse. *Æ. ænigmatica*, Chemn. (cxxxi, 75). Lives attached to trees in mangrove-swamps.

LIMANOMIA (*Grayana*), Bouchard. Fossil, 4 sp. Devonian; Boulogne. Inequivalve, valves thin near the beaks, slightly radially ribbed; lower valve with a trigonal cut under the ear and near the beak.

PLACUNOPSIS, Morr. and Lycett, 1853. Suborbicular, generally somewhat irregular, inequivalve; larger valve convex, with small submarginal, submedian beak, and mostly ornamented with radiating ribs or striæ; smaller valve flat, free, or attached to foreign objects; hinge toothless, with a small cartilage-pit in each valve; muscular scar large, subelliptical, subcentral. Type, *P. Jurensis*, Roem. All the species as yet known are from Jurassic deposits, but it is not certain whether all the Jurassic species referred to Placunopsis agree with the characteristics above noticed; many of them appear to belong to Anomia (typical), and doubts are expressed on this point even regarding the type species, *P. Jurensis*.

PLACUNANOMIA, Broderip, 1832.

Distr.—13 sp. West Indies, Britain, New Zealand, California,

Behring's Sea, Ochotsk; 50 fathoms. Miocene; California. *P. macrochisma*, Desh. (cxxxi 76).

Shell adherent, subequivalve, irregular, flattened; hinge with two thick, divergent elongated lamella in the inferior, corresponding with two long pits in the upper valve; upper valve with only two muscular impressions; the pedal scar radiately striated; the byssal plug is often fixed in the lower valve, and its muscle becomes (functionally) an adductor.

PODODESMUS, Philippi, 1849. Valves radiately grooved; perforation of lower valve moderate, firmly embracing and enclosing the plug. *P. rudis*, Brod. (cxxxi, 77).

MONIA, Gray, 1849. Valves radiately grooved; perforation of lower valve large, only slightly embracing the large, thin, plug. *P. Zealandica*, Gray (cxxxiii, 26).

PARANOMIA, Conrad, 1860. Irregular, inequivalve, one valve flattened or slightly concave, hinge of lower valve with a broad, irregular, triangular tooth or plate, flattened or slightly convex, with sharp margins and an anterior, compressed, small, but prominent tooth; muscular impression situated toward the ventral margin in a line with the apex, or nearly equidistant from the anterior and posterior ends. Type, *Placunanomia Saffordi*, Con., from cretaceous rocks of Tennessee. There are only two other cretaceous species which Conrad refers to the same group; it seems to be closely allied to Philippi's Pododesmus. The convex valve has no teeth or appendage, and is generally radiately ribbed; the flatter valve is often attached near the umbo to other objects and very thin, but not perforated.

CYCLOSTREON, Eichwald, 1867.

Distr.—Fossil. Cret., Eocene; Europe.

Shell obliquely ovate, with attenuated obtuse beaks, inequivalve; one (right?) valve convex; the other (left?) smaller, flat or concave, with a small transverse ligamental groove at the apex; in the convex valve there is only a small lateral groove below the beak, placed somewhat anteriorly; both beaks are truncate and appear to indicate an attachment to foreign bodies; muscular impression indistinct, represented by a marginal zone which surrounds the cavity of the convex valve. The type greatly resembles Hemiplicatula, but is stated to have no such hinge or cartilage ribs as are characteristic of that genus.

ANOMIANELLA, Ryckholt, 1852.

Distr.—*A. proteus*, Ryck. (cxxxii, 12). Carboniferous; Belgium.

Shell ovate, thin, found attached to other shells; there appears to be no perforation in the lower valve.

DIPLOSCHIZA, Conrad, 1866.

Distr.—*D. cretacea*, Conr. (cxxxiii, 27, 28). Cret.; Ala.

Subovate, inequivalve, smaller valve concave, both of a laminated structure and with truncate, deeply notched or emarginated beaks.

Conrad says that "the shell seems to have been attached by the umbo of the larger valve, the truncature of which reminds us of the truncated beak of Terebratula." It is a curious shell and indicates great similarity to a brachiopod form.

OSTRENOMIA, Conrad, 1872.

Distr.—*O. Carolinensis*, Conr. (cxxxiii, 29, 30). Eocene; N. Carolina.

Shell inequivalve, irregular, laminated; hinge with a triangular cartilage-pit; right valve with a deep notch or sinus having an internal raised margin; left valve with an angular dentiform process at the base of the cartilage-pit.

CAROLIA, Cantraine, 1835.

Dedicated to Prince Charles Bonaparte.

Syn.—Hemiplacuna, G. Sowerby.

Distr.—3 sp. Tertiary; Egypt. *C. placunoides*, Cantr. (cxxxii, 2).

Shell like Placuna; hinge, when young, like Anomia, with a byssal plug passing through a small deep sinus in front of the cartilage-process, which is closed in the adult.

FAMILY PLACUNIDÆ.

Shell equivalve or nearly so, compressed, thin, pearly, externally often finely lamellar; ligament marginal, cartilage attached to the external side of two diverging ribs in one valve, corresponding to two similar grooves or ribs in the other valve.

Free, without byssus, found on sandy shores.

PLACUNA, Solander.

Etym.—*Plakous*, a thin cake. Window-shell.

Distr.—4 sp. Scinde, North Australia, China. *P. orbicularis*, Retz. (cxxxiii, 31).

Shell suborbicular, compressed, translucent, free, resting on the right valve; hinge-area narrow and obscure; cartilage supported by two diverging ridges in the right valve and corresponding grooves in the left; muscular impressions double, the larger element round and central, the smaller distinct and crescent-shaped, in front of it.

The Placunæ are very closely allied to Anomia; and many intermediate forms may be traced. The shell of each consists

entirely of subnacreous, plicated laminæ, peculiarly separable, and occasionally penetrated by minute tubuli.—CARPENTER.

P. sella, called from its shape the "saddle-oyster," is remarkably striated.

Placuna is essentially like Anomia, having the generative system attached to the right mantle-lobe, and the ventricle exposed. The mantle-margin is cirrated, and furnished with a curtain, as in Pecten; the foot is tubular and extensile, the small muscular impressions before and in the rear of the adductor are produced by suspensors of the gills.

PLACENTA, Auct. (Not Retzius, 1788 = Placuna. Placunema, Stoliczka, 1870.) Shell thin, suborbicular, semitransparent; cartilage-grooves and lamellæ slightly divergent, the posterior longest; muscular impression subcentral. *P. sella*, Gmel. (cxxxi, 78). China.

PSEUDOPLACUNA, Mayer, 1876. Shell lenticular, rather thick, almost smooth and nearly equivalve; upper valve swollen; muscular impression large, round, central, approaching the hinge; hinge-lamellæ strongly diverging, dissimilar. *P. Helvetica*, Mayer. Eocene; Eur.

SAINTIA. Raincourt, 1877. Shell small, rounded, smooth; muscular impression large, approaching the posterior margin; hinge with two diverging lamellæ enclosing a third very small tooth. *S. Munieri*, Raincourt (cxxxii, 10, 11). Fossil; Paris Basin.

HEMIPLICATULA, Desh., 1864.

Distr.—*H. solida*, Desh. (cxxxiii, 32, 33). Fossil; Paris Basin.

Shell roundly oval, solid, compressed, subequivalve, hinge with two slightly diverging hinge-ribs in each valve, those of the right valve fitting between those of the left, which are less elevated and have between them a small fosset; the cartilage is attached, as in Placuna, along the external sides of the hinge-ribs, and this forms the principal distinction between the present genus and Plicatula, where the cartilage is situated in the median pit.

? BICORIUM, Meyer, 1880. *B. irregulare*, Meyer. Oligocene; Germany.

(*Ostracea.*)

FAMILY OSTREIDÆ.

Shell inequivalve, slightly inequilateral, free or adherent, resting on one valve; beaks central, straight; ligament internal; epidermis thin; adductor impression single, behind the centre; pallial line obscure; hinge usually edentulous.

Animal marine; mantle quite open; very slightly adherent

to the edge of the shell; foot small and byssiferous, or obsolete; gills crescent-shaped, two on each side; adductor muscle composed of two elements, but representing only the posterior shell-muscle of other bivalves.

The union of the Ostreidæ and Pectinidæ, as proposed by the authors of the "History of British Mollusca," has not proved satisfactory. The genus Ostrea stands quite alone, and distinct from all the Pectinidæ in the structure of its gills, which are like those of Avicula, and by resting on its left valve. The shell also is more nacreous than that of the scallops.

OSTREA, Linn.

Syn.—Peloris, Poli.

Distr.—70 sp. Tropical and temperate seas. Norway, Black Sea, etc. Fossil, 200 sp. Carb.—; United States, Europe, India. *O. Virginica*, Linn. (vol. i, t. 22; cxxxiii, 34).

Shell irregular, attached by the left valve; upper valve flat or concave, often plain; lower convex, often plaited or foliaceous, and with a prominent beak; ligamental cavity triangular or elongated; hinge toothless; structure subnacreous, laminated, with prismatic-cellular substance between the margins of the laminæ.

Animal with the mantle-margin double, finely fringed; gills nearly equal, united posteriorly to each other and the mantle-lobes, forming a complete branchial chamber; lips plain; palpi triangular, attached; sexes distinct.

The interior of recent oyster-shells has a slightly nacreous lustre; in fossil specimens an irregular cellular structure is often very apparent on decomposed or fractured surfaces. Fossil oysters which have grown upon Ammonites, Trigoniæ, etc., frequently take the form of those shells.

In the "cock's-comb" oysters both valves are plaited; *O. diluviana* sends out long root-like processes from its lower valve. The "tree-oyster" (Dendrostrea, Sw.) grows on the root of the mangrove. Oyster-shells become very thick with age, especially in rough water; the fossil oyster of the Tagus (*O. longirostris*) attains a length of two feet; *O. Talienwanensis*, Crosse, grows to the length of three feet in the Bay of Taichou, Japan. The greatest enemy of oyster-banks is a sponge, which eats into the valves, both of dead and living shells; at first only small round holes, at irregular intervals, and often disposed in regular patterns, are visible; but ultimately the shell is completely mined and falls to pieces.

EXOGYRA, Say. (Amphidonta, Fischer. Ceratostreon, Rhynchostreon, Bayle, 1879.) Shell Chama-shaped, attached by the left valve; umbones subspiral, turned to the posterior side (*i. e.* reversed); right valve opercular. *O. Humboldtii*, Fischer

(cxxxii, 3). Fossil, 46 sp. L. Oolite—Chalk; United States, Europe.

ALECTRYONIA, Fischer de Waldheim, 1825. (Lopha, Bolten, 1798. Dendostrea, Swainson, 1840. Actinostrea, Bayle.) Shell plicate, strongly so towards the margins; adherent partly by recurved spinous processes clasping the limbs or roots of trees, as mangroves, etc. *O. frons*, Linn. (cxxxi, 79).

GRYPHÆA, Lamarck, 1801. (Pycnodonta, Fischer, 1835.) Shell free or very slightly attached; left valve with a prominent incurved umbo; right valve small, concave. Fossil, 30 sp. Liassic—Cretaceous; Eur., India, U. S. *O. angulata*, Lam. (cxxxii, 4).

GRYPHÆOSTREA, Conrad, MSS. Shell thin, elongate, straight, narrow; lower valve rather deep and smooth; upper valve flat or slightly concave, and ornamented with distant, regular, thin, concentric laminæ; beak of lower valve contorted, or turned to one side; cartilage-pit narrow, oblique. In perfectly preserved specimens the typical species, *O. vomer*, throws out long, slender auricular appendages (one on each side) from the lower valve near the beak. They are usually broken off, but appear to have attached the species.

MOLLUSCOIDA.

Class BRACHIOPODA.

The animals, and more especially the shells of this class of molluscoids, were for a long period regarded as belonging to true mollusca, and so uniformly are they still the objects of conchological study that a treatise upon that science would be very incomplete for practical use, if the Brachiopoda were excluded. On the other hand, the two other classes of Molluscoida, the Tunicata and Bryozoa, are beyond the usual scope of conchological investigation, and as this work would be considerably increased in bulk and cost by the description and illustration of their systematic groups, they are omitted.

Steenstrup, Morse, Kowalevsky and other eminent investigators, have concluded, mainly from embryological data, that the brachiopods form a portion of the subkingdom Annulosa, and are nearly related to the annelids or worms. Dall and Stoliczka have maintained the molluscoid affinities of the class. Thomas Davidson, who has made a specialty of the study of the Brachiopoda, summarizes the arguments of these naturalists and thus concludes:

"No one can doubt that the brachiopods and Amphitrites possess many important characters in common after perusing the admirable observations upon the subject contained in Prof. Morse's memoir; but at the same time, as was remarked to me by Prof. Verrill, almost any invertebrate group may be annelid-elized by overrating certain points of its affinities; and it seems to me that one must not place entire confidence in any classification which is founded to so great an extent on embryological characters."

Huxley writes: "The acceptance of the view originally propounded by Steenstrup and so ably urged by Professor Morse, respecting the affinities of the brachiopods with the worms, does not to my mind weaken the opinion I have always held as to their affinities with the Bryozoa on the one hand, and with the higher Mollusca on the other."

To give even a succinct statement of the conflicting views of the authors first mentioned would unduly increase the number of my pages; those who wish to pursue the subject further may read with interest and profit:

E. S. Morse.—American Journal of Science and Arts, p. 100, July, 1870.
Proc. Bost. Soc. Nat. Hist., xv, 1873.
Memoirs Bost. Soc. Nat. Hist., ii, 29, 1871.
Wm. H. Dall.—Am. Jour. Conchology, vi, 88, 1871; vii, 39, 1872.
A. Agassiz.—Review of Kowalevsky's Memoir, Am. Jour. of Science and Arts, 3d ser., viii, 470, 1874 (Kowalevsky published in Russian).
F. Stoliczka.—Palæontologica Indica, vol. iv, Brachiopoda.

Davidson's paper, "What is a Brachiopod?" may also be consulted by those desirous of reading a fuller account of the group than is given in these pages. Geological Magazine (London), for 1877; or a French translation in Annales de la Société Malacologique de Belgique, x, 1876.

The Brachiopoda (= Order Palliobranchiata, Blainville, 1814) are bivalve molluscoids, which differ from the ordinary mussels, cockles, etc., in being always equal-sided and never quite equivalve. Their forms are symmetrical, and so commonly resemble antique lamps, that they were called *lampades*, or "lamp-shells," by the old naturalists (Meuschen, 1787; Humphreys, 1797); the hole which in a lamp admits the wick serves in the lamp-shell for the passage of the pedicel by which it is attached to submarine objects.

The valves of the Brachiopoda are respectively dorsal and ventral; the ventral valve is usually largest, and has a prominent beak, by which it is attached, or through which the organ of adhesion passes. It is sometimes perforated, as in the Terebratulidæ. The dorsal or smaller valve is always free and imperforate. The valves are articulated by two curved teeth, developed from the margin of the ventral valve, and received by sockets in the other; this hinge is so complete that the valves cannot be separated without injury. A few genera have no hinge; in Crania and Discina the lower valve is flat, the upper like a limpet; the valves of Lingula are nearly equal, and have been compared to a duck's bill.

This and several other points of difference seem to show the propriety of adopting the proposal made by Deshayes in 1836 of

dividing the brachiopods into two great groups, the one having articulated, the other non-articulated valves. In the first, moreover, the valves are opened by muscles acting on the cardinal process of the dorsal valve, while in the latter the valves are opened by the pressure of the fluid in the perivisceral cavity. This difference is accompanied by a striking variation in the arrangement of the muscles. The articulated group possess an anal aperture; the unarticulated none.

The valves are both opened and closed by muscles (cxxxiv, 1); those which open the shell (cardinales) originate on each side the centre of the ventral valve, and converge towards the hinge-margin of the free valve, behind the dental sockets, where there is usually a prominent cardinal process. The teeth form the fulcrum on which the dorsal valve turns. The adductor muscles are four in number, and quite distinct in Crania and Discina; in Lingula the posterior pair are combined, and in Terebratula the four muscles are separate at their dorsal terminations, but united at their insertion in the centre of the larger valve. The pedicel is fixed by a pair of muscles (each doubly attached) to the dorsal hinge-plate, and by another pair to the ventral valve, outside the cardinal muscles.

In the Terebratulidæ and the other brachiopods having articulated valves the muscular system consists of three pairs of muscles which act directly on the valves, and of three pairs which connect the shell, and adjust it with respect to the peduncle. In the unarticulated brachiopods, such as Lingula, the muscles are more complicated than in the former group; three pairs of protractor muscles keep the valves together, and thus compensate for the absence of the hinge and condyles, which help to form this function in the articulated group; they are so arranged as to co-operate in preventing any displacement of the valves in any direction. Hence the term sliding-muscles which they have received is inappropriate, since they prevent any sliding action. In the lamellibranchs the sliding of the valves is admirably guarded against by means of hinges with teeth and sockets; in brachiopods the same end is apparently obtained by means of muscles.

The muscles are remarkably glistening and tendinous, except at their expanded ends, which are soft and fleshy. They are, with few exceptions, non-striated. In the posterior adductors of Waldheimia transverse striations are well displayed. Their impressions are often deep, and always characteristic; but difficult of interpretation from their complexity, their change of position, and the occasional suppression of some and combination of others. There may be considerable changes in arrangement of muscles without any important change in the internal

structure. Thus in *Waldheimia cranium* there are six muscular impressions in the dorsal valve; in *W. australis* there are only four, the other two muscles being attached to the hinge-plate, not to the valve. The valve and hinge-plate are never found together, and it is, therefore, probable that in the fossil species, the shells of which are found without hinge-plates, the muscles may have been arranged as in *W. cranium*.

On separating the valves of a recent Terebratula, the digestive organs and muscles are seen to occupy only a very small space near the beak of the shell, partitioned off from the general cavity by a strong membrane, in the centre of which is placed the animal's mouth. The large cavity is occupied by the fringed arms, the characteristic organs of the class. Their nature will be better understood by comparing them with the lips and labial tentacles of the ordinary bivalves; they are, in fact, lateral prolongations of the lips supported on muscular stalks, and are so long as to require being folded or coiled up. In Rhynchonella and Lingula the arms are spiral and separate; in Terebratula and Discina they are only spiral at the tips, and are united together by a membrane, so as to form a lobed disk. It has been conjectured that the living animals have the power of protruding their arms in search of food; but this supposition is unlikely, since in many genera they are supported by a brittle skeleton of shell, while the food is obtained by means of currents created by cilia. Lingula may have the power of slightly extending the arms. The internal skeleton consists of two spiral processes in the Spiriferidæ, whilst in Terebratula and Thecidium it takes the form of a loop, which supports the brachial membrane, but does not strictly follow the course of the arms. The mode in which the arms are folded is highly characteristic of the genera of Brachiopoda; the extent to which they are supported by a calcareous skeleton is of less importance, and liable to be modified by age. That margin of the oral arms which answers to the lower lip of an ordinary bivalve, is fringed with long filaments (cirri), as may be seen even in dry specimens of recent Terebratulæ. In some fossil examples the cirri themselves were supported by slender processes of shell; they cannot, therefore, be vibratile organs, but are probably themselves covered with microscopic cilia, like the oral tentacles of the ascidian polypes. The anterior lip and inner margin of the oral arms are plain, and form a narrow gutter along which the particles collected by the ciliary currents may be conveyed to the mouth. The object of the folding of the arms is obviously to give increased surface for the disposition of the cirri.

The mouth conducts by a narrow œsophagus to a simple stomach, which is surrounded by the large and granulated

liver; the intestine of Lingula is reflected dorsally, slightly convoluted, and terminates between the mantle-lobes on the right side. In Orbicula it is reflected ventrally, and passes straight to the right, ending as in Lingula. In Terebratula, Rhynchonella, and probably all the articulated Brachiopoda, the intestine is simple and reflected ventrally, passing through a notch or foramen in the hinge-plate, and ending behind the ventral insertion of the adductor muscle.

The circulatory system is far less complex than was formerly supposed, and does not differ greatly from the same system in the Tunicata. The heart is placed on the dorsal surface of the stomach, and consists of a simple, unilocular, pyriform vesicle without any auricle. From it the blood is propelled through four channels to the organs of reproduction and to the mantle; and its flow is probably assisted by a number of subsidiary pulsatile vesicles situated on the main arterial trunks. It then courses through the plexus of lacunes in the pallial sinuses and lobes; turns back through the lacunes of the parietes into the system of visceral lacunes. It probably enters the liver, and ultimately finds its way back into the heart through the branchio-systemic vein. There is, however, another and more important blood current, which traverses the whole length of the brachial canal, and penetrates to the extremities of the cirri, before it joins the current returning from the visceral lacunes and flows with it into the branchio-systemic vein. The blood which has passed through the brachial canal is far more highly oxygenated than the blood which has flowed through the pallial membranes. There seems to be strong evidence that the so-called arms, which serve to bring food to the creature's mouth by the means before noticed, also subserve the purpose of respiratory organs. The mantle is an accessory breathing-organ. It attains its highest development as such in Lingula, but even in this genus the brachial apparatus performs the chief part in oxygenating the blood.

There is another system of canals which take their rise from the visceral cavity. What its function is has not been determined; it is not the blood system as was formerly imagined, and has no connection with it. The perivisceral cavity and the visceral lacunes which diverge from it may, it is thought, be homologous to the water-vascular system in Polyzoa, the function of which is probably to evacuate the effete nitrogenized products which have been eliminated from the blood. Consequently it would perform the offices both of the kidney and the renal organs.

The generative organs occupy the great pallial sinuses, and the sexes are separate. In the articulated brachiopods the

ovaries and testes are placed in the mantle; but in Lingula and Discina they occur in the perivisceral chamber. The ova escape into the oviducts (regarded by Cuvier and others as hearts), which open externally, and have nothing to do with the vascular system. In Rynchonella there are four oviducts, but in most, if not all the other brachiopods, there are only two. In Terebratulidæ they are divided into two portions, called the auricle and ventricle by Professor Owen. Mature eggs have been found in large numbers in the perivisceral chamber and in the oviducts. Recent Discinæ often have minute fry attached to their valves, and Mr. Suess, of Vienna, has noticed a specimen of the fossil Stringocephalus, which contained numerous embryo shells.

As yet we know little respecting the development of the Brachiopoda, but in their first stage they are free and able to swim about until they meet with a suitable position. It is probable that in the second stage they all adhere by a byssus, which in most instances becomes consolidated, and forms a permanent organ of attachment. (Prof. Morse describes the embryo of Terebratulina with great minuteness during its six stages of development. It is divided into two, three, or four lobes clothed with vibratile cilia; and before becoming attached swims or whirls head foremost by means of the cilia covering the body.) Some of the extinct genera (*e. g.* Spirifera and Strophomena) appear to have become free when adult, or to have fixed themselves by some other means. Four genera, belonging to very distinct families, cement themselves to foreign objects by the substance of the ventral valve.

The nervous system exhibits a state of development but little superior to what is found in Ascidians. No special organs of sense have been detected. The red spots in the mantle, supposed by some to be rudimentary eyes and ears, are probably the glands situated at the base of the setæ.

Some of the Brachiopoda appear to attain their full growth in a single season, and all probably live many years after becoming adult. The growth of the valves takes place chiefly at the margin; adult shells are more globular than the young, and aged specimens still more so. The shell is also thickened by the deposit of internal layers, which sometimes entirely fill the beak, and every portion of the cavity of the interior which is not occupied by the animal, suggesting the notion that the creature must have died from the plethoric exercise of the calcifying function, converting its shell into a mausoleum, like many of the ascidian zoophytes.

The intimate structure of the shell of the Brachiopoda has been investigated by Mr. Morris, Professor King, and more

recently by Dr. Carpenter; according to this last observer, it consists of flattened prisms of considerable length, arranged parallel to each other with great regularity, and obliquely to the surfaces of the shell, the interior of which is imbricated by their out-crop. This structure is found only in the Rhynchonellidæ; but in most—perhaps all the other Brachiopoda—the shell is traversed by canals from one surface to the other, nearly vertically, and regularly, the distance and size of the perforations varying with the species (vol. i, t. 1, f. 5). Their external orifices are trumpet-shaped, the inner often very small; sometimes they bifurcate towards the exterior, and in Crania they become arborescent. The canals are occupied by cœcal processes of the outer mantle-layer, and are covered externally by a thickening of the epidermis. Mr. Huxley has suggested that these cœca are analogous to the vascular processes by which in many ascidians the tunic adheres to the test; the extent of which adhesion varies in closely allied genera. The large tubular spines of the Productidæ must have been also lined by prolongations of the mantle; but their development was more probably related to the maintenance of the shell in a fixed position, than to the internal economy of the animal.—King. Dr. Carpenter states that the shell of the Brachiopoda generally contains less animal matter than other bivalves; but that Discina and Lingula consist almost entirely of a horny animal subtance, which is laminar, and penetrated by oblique tubuli of extreme minuteness. He has also shown that there is not in these shells that distinction between the outer and inner layers, either in structure or mode of growth, which prevails among the ordinary bivalves; the inner layers only differ in the minute size of the perforations, and the whole thickness corresponds with the outer layer only in the Lamellibranchiata. The loop, or brachial processes, are always impunctate. Mr. Hancock's researches would tend to show that these conclusions are generally correct, but not entirely so. "When the shell is dissolved in acid the free border [of the mantle] which projects beyond the marginal fold, and which is applied to the extreme edge of the shell, can be examined with advantage. The pallial cœca are then completely exposed appended to the membrane in various stages of development, and the spaces between them are found studded all over with rather large, clear, oval, cell-like spots, which are arranged with considerable regularity in rows, so that those in the approximate rows alternate. These spots apparently correspond to the bases of the prismatic columns of the shell; and if it be allowed that they represent spaces in which calcareous granules had been accumulated, it is easy to understand how the fibrous or columnar structure is formed. A succession of layers of such

accumulated granules deposited one after the other would result in the peculiar shell formation of the Brachiopoda." The extremities of the prisms are not visible on the external surface, but in the young individual of some species, as *Terebratula caput-serpentis*, there is a thin layer of calcareous matter, which seems to show that in some brachiopods the shell is composed of two layers of shell, having a different structure, as in the case of the Conchifera.

The Lamp-shells are all natives of the sea. They are found hanging from the branches of corals, the under sides of shelving rocks, and the cavities of other shells. Specimens obtained from rocky situations are frequently distorted, and those from stony and gravelly beds, where there is motion in the waters, have the beak worn, the foramen large, and the ornamental sculpturing of the valves less sharply finished. On clay beds, as in the deep clay strata, they are seldom found; but where the bottom consists of calcareous mud they appear to be very abundant, mooring themselves to every hard substance on the sea-bed, and clustering one upon the other.

Of all mollusca the Brachiopoda enjoy the greatest range both of climate, and depth, and time; they are found in tropical and polar seas; in pools left by the ebbing tide, and at the greatest depths hitherto explored by the dredge. At present comparatively few recent species are known; but many more will probably be found by dredging in the deep sea, which these shells mostly inhabit. The number of living species is already greater than has been discovered in any *secondary* stratum, but the vast abundance of fossil *specimens* has made them seem more important than the living types, which are still rare in the cabinets of collectors, though far from being so in the sea. Above 4000 extinct species of Brachiopoda have been described, of which a large proportion are found in Europe. They are distributed throughout all the sedimentary rocks of marine origin from the Cambrian strata upwards, and appear to have attained their maximum of specific development in the Silurian age. Some species (like *Atrypa reticularis*) extend through a whole "system" of rocks, and abound equally in both hemispheres; others (like *Spirifera striata*) range from the Cordillera to the Ural mountains. One recent Terebratula (*caput-serpentis*) made its appearance in the Miocene Tertiary; whilst others, scarcely distinguishable from it, are found in the Upper Oolite and throughout the Chalk series and London Clay.—WOODWARD.

Geological Distribution of the Families of Brachiopods.

	Cambrian.	Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Recent.
ARTHROPOMATA.										
Terebratulidæ, ...		*	*	*	*	*	*	*	*	*
Thecideidæ, ...				?	?	*	*	*	*	*
Stringocephalidæ, . . .			*							
Rhynchonellidæ, ...		*	*	*	*	*	*	*	*	*
Atrypidæ, ...		*	*	?	?					
Spiriferidæ, ...		*	*	*	*	*	*			
Koninckinidæ, ...			*			*	*			
Strophomenidæ, ...	*	*	*	*	*	*	*			
Ptoductidæ, ...		*	*	*	*					
LYOPOMATA.										
Craniadæ, ...		*	*	*	*	*	*	*	*	*
Trimerellidæ, ...		*								
Discinidæ, ...	*	*	*	*	*	*	*	*	*	*
Obolidæ, ...	*	*								
Lingulidæ, ...	*	*	*	*	*	*	*	*	*	*

ORDER ARTHROPOMATA.

(Apygia, Bronn. Articulata, Huxley.)

Shell testaceous, articulated by hinge-teeth, with usually an internal skeleton-like testaceous process. Animal destitute of an anal aperture (Clistenterata, King).

FAMILY TEREBRATULIDÆ.

Shell minutely punctate; usually round or oval, smooth or striated; ventral valve with a prominent beak, perforated near or at the apex, and attached by a peduncle passing through the perforation, or by a portion of the valve itself; hinge with two curved teeth; dorsal valve with a depressed umbo, a prominent cardinal process between the dental sockets, and a slender shelly loop.

Animal attached by a pedicel, or by the ventral valve; oral arms united to each other by a membrane, variously folded; sometimes spiral at their extremities.

TEREBRATULA, Müller, 1776.

Etym.—Diminutive of *terebratus*, perforated. Lamp-shell.

Syn.—Lampas, Humph., 1797. Gryphus, Muhlfeldt, 1811. Epithyris, Phil., 1841. Liothyris, Douvillé, 1879.

Distr.—8 sp. West Indies, Mediterranean; 90–250 fathoms on nullipore mud. (Forbes.) Vigo Bay, Falkland Islands, Japan. Fossil, very numerous species. Triassic—; world-wide. *T. maxillata*, Sowb. (cxxxiv, 2). *T. vitrea*, Linn. (cxxxiv, 6, 7). *T. sella*, Sowb. (cxxxiv, 5). *T. Phillipsii*, Morris (cxxxiv, 3, 4).

Shell smooth, convex; beak truncated and perforated; foramen circular; deltidium of two pieces frequently blended; loop very short, simple, attached by its crura to the hinge-plate.

Animal attached by a pedicel; brachial disk trilobed, centre lobe elongated and spirally convoluted.

Douvillé has proposed the name Liothyris for shells without folds, like *T. vitrea*, L. (cxxxiv, 6, 7), but there are so many intermediate stages that the division cannot be maintained; some young individuals are unfolded, but acquire the folds in growth.

PYGOPE, Link, 1830. (Diphytes Schröt., 1779. Antinomia, Catullo, 1850. Pugites, DeHaan, 1833. Glossothyris, Douvillé, 1879.) Ventral valve bilobed when young; when adult, the lobes unite, leaving a round hole in the centre of the shell. Jurassic and Cretaceous; Southern Europe. *T. diphoides*, d'Orb. (cxxxiv, 8–10). *T. diphya*, Colonna (cxxxiv, 11).

DICTYOTHYRIS, Douvillé, 1879. Ventral valve two-folded with a median depression; dorsal valve with a strong median swelling, bordered by channels; surface radiately striate, crossed by concentric growth-lines forming tubercles at their intersection. Jurassic and Cretaceous.

CŒNOTHYRIS, Douvillé, 1879. Shell oval, smooth; tooth-plate strongly developed; apophyses independent of the cardinal teeth, from which they are separated by a diverging slit; a septum present, as in Waldheimia. *T. vulgaris*, Schloth. (cxxxiv, 12).

DIELASMA, King, 1859.

Syn.—Epithyris, King (part), 1850. Seminula, M'Coy (part), 1855. Cyrptacanthia, White and St. John, 1868.

Distr.—Permian—; Eur., N. Am. *D. elongata*, Schloth. (cxxxiv, 13).

Shell with lamellæ supporting the teeth of the neural valve, a short loop as in Terebratula but more abruptly sinuated anteriorly, and with the central lamina of the hinge-plate in the hæmal valve produced in the form of a mason's trowel, and supported beneath by a mesial septum.

TEREBRATULINA, d'Orbigny, 1847.

Syn.—Agulhasia, King, 1871.

Distr.—8 sp. United States, Norway, Australia, Cape, Japan;

10–120 fathoms. Fossil, 22 sp. Jurassic—; United States, Europe. *T. caput-serpentis*, Linn. (cxxxiv, 14–16).

Shell finely dichotomously striated, auriculate, deltidium usually rudimental; foramen incomplete; loop short, rendered annular in the adult by the union of the oral processes.

WALDHEIMIA, King, 1849.

Syn.—Magellania, Bayle, 1880.

Distr.—9 sp. Norway, W. Indies, Java, Australia, California, Cape Horn; low-water—100 fathoms. Fossil, 90 sp. Carb.—; South America, Europe. *W. Australis*, Quoy (cxxxiv, 1, 17–19). *W. flavescens*, Lam. (cxxxiv, 20–22).

Shell smooth or plaited, dorsal valve frequently impressed; foramen complete; loop elongated and reflected; septum of smaller valve elongated.

WALDHEIMIA (restricted), Dall, 1871. Shell globose, neural beak more or less produced; foramen complete or incomplete; deltidia separated or united; pedunculated; a ridge or septum usually existing in the hæmal valve. Mouth behind the brachia, which consist of two lateral lobes and a central spiral lobe. *W. flavescens*, Lam.

EUDESIA, King, 1850. Shell swollen, oval; valves sharply plaited; beak-opening round, large; median septum and tooth-plates developed. *W. Grayi*, Davidson, and 6 fossil sp.

MACANDREVIA, King, 1859. (? Gwynia, King, 1859. Neothyris and Plesiothyris, Douvillé, 1879.) Smooth, longitudinally oval, inequivalve, the condyle valve being the largest; foramen emarginated by the deltidial fissure; umbonal cavity of large valve furnished with two muscular fulcral plates passing somewhat perpendicularly from the dental protuberances to the surface of the valve; umbonal cavity of opposite valve also furnished with similarly directed plates; cardinal muscular fulcrum excavated in the substance of the hinge; loop long, strongly recurved, and extending in front of the centre of the valve. Includes the recent *W. cranium*, Müll., which is the type, and a number of fossil forms.

ZEILLERIA, Bayle, 1879. (Macandrewia, Schloen. Orthotoma, Quenst., 1871.) Differs from Waldheimia in the presence of two rostral partitions upon the hinge. Jurassic—Tertiary; Europe. *W. lagenalis*, Schloth. (cxxxiv, 23).

AULACOTHYRIS, Douvillé, 1879. Apophyses, rostral partitions and septum as in Zeilleria; foramen generally small and oblong. Distinguished by its exterior form, the smaller valve having a median furrow. Triassic, Jurassic, Cretaceous. *W. resupinata*, Sowb. (cxxxv, 24).

ANTIPTYCHINA, Zittel, 1880. Large valve swollen in the middle, with a strong fold on either side; small valve usually somewhat

flatter, with a deep marginal sinus, folded in the middle; loop very long, fringed, the blades widened near the connecting bridge; septum strong. Jurassic, Cretaceous. *W. bivallata*, Deslong.

CRYPTONELLA, Hall, 1867. Loop exactly resembling that of Waldheimia proper, except in the addition of a transverse band from one side of the apophyses to the other behind the crura. Devonian. *W. rectirostra*, Hall.

MEGANTERIS, Suess, 1856. Shell orbiculate, somewhat compressed, nearly equivalve; area of neural valve small, apex inconspicuous, minutely foraminated, punctate; deltidia small, wide, united; cardinal process prominent, with a V-shaped process near the apex for the insertion of the cardinal muscles, sulcated on each side, with the base excavated; cardinal border broad, wide, rugose; loop essentially as in Waldheimia, but with very long crura, the main stems of the apophyses being given off at a sharp angle with the crura, reflected abruptly and the posterior part of the reflected loop behind and below the crura; there is a faint mesial septum in the hæmal valve. Sil.; N. Am. Dev.; Eur. *W. Archiaci*, Suess.

CENTRONELLA, Billings, 1859.

Etym.—Diminutive of *kentron*, a spur.

Syn.—Cryptonella, Hall (part).

Distr.—4 sp. Devonian; North America. *C. glans-fagea*, Hall (cxxxv, 25, 26).

Shell having the general form of Terebratula. Dorsal valve with a loop consisting of two riband-like lamellæ, which were united at an acute angle at the point of greatest extension, whence they recurve in a thin vertical plate which is not attached at either margin.

LEPTOCŒLIA, Hall, 1859. Appears to differ from Centronella only in consisting of species which have the surface ribbed instead of smooth. 9 sp. Mid. Silurian—Devonian; Europe, North America. No true Terebratulæ have been found in beds older than the Devonian. *L. imbricata*, Hall.

? HINNIPHORIA, Suess, 1858. *H. globularis*, Suess. Jurassic; Stramberg.

RENSSELÆRIA, Hall, 1859.

Etym.—Dedicated to the late Hon. Stephen Van Rensselaer.

Syn.—Atrypa, Conr., 1839. Pentamerus, Vanuxem, 1843.

Distr.—Fossil, 11 sp. Silurian—Devonian; Europe, N. Am. *R. ovoides*, Hall (cxxxv, 27).

Shell ovoid or suborbicular, without mesial fold or sinus; beak prominent, acute, more or less incurved; foramen terminal, sometimes concealed. Ventral valve with two diverging cardinal teeth supported by strong dental plates. Dorsal valve with the dental sockets between the shell and a strong process from which

the slender crura proceed, first in a direct line, and then one division of each, diverging into the centre of the ventral valve, terminate in acute points. On the other side the divisions extend nearly at right-angles to the axis of the shell into the cavity of the dorsal valve; and thence bending abruptly forward and gradually converging, terminate above the centre of the shell in a thin flattened or longitudinally concave plate.

TEREBRATELLA, d'Orbigny, 1847.

Syn.—Delthyris, Menke, 1830. Ismenia, King, 1850.

Distr.—Excluding subgenera, 12 sp. Cape Horn, Valparaiso (ninety fathoms), New Zealand, Japan, California, Ochotsk, Spitzbergen, Labrador. Fossil, 16 sp. Lias—; United States, Europe. *T. Magellanica*, Chemn. (cxxxv, 28, 29).

Shell smooth or radiately plaited; dorsal valve longitudinally impressed; hinge-line straight, or not much curved; beak with a flattened area on each side of the deltidium; foramen large; deltidium incomplete; loop attached to the septum.

Animal like Terebratula; the spiral lobe of the brachial disk becomes very diminutive in some species, and is obsolete in *T. Cumingii.*

WALTONIA, Davidson, 1850. Shell with the beak truncated by a large incomplete foramen; deltidia separate. Loop reduced to two simple lamellæ furnished with oral processes and attached to a prominent central septum. *T. Valenciennesii*, Davidson. Perhaps the fry of *Ter. rubicunda*, with the reflected part of the loop wanting.

TRIGONOSEMUS, König, 1825. (Delthyridea, King, 1850. Fissirostra, d'Orbigny, 1847.) Shell finely plaited, beak prominent, curved, with a narrow apical foramen; cardinal area large, triangular; deltidium solid, flat; cardinal process very prominent. 5 sp. Chalk; Europe. *T. elegans*, König (cxxxv, 30–32). *T. Palissii*, Wood (cxxxv, 33).

LYRA, Cumberland, 1816. (Terebrirostra, d'Orb, 1847.) Shell ornamented with rounded ribs; beak very long, divided lengthwise internally by the dental plates; loop doubly attached? 4 sp. Cretaceous; Europe. Three species of similar form are found in the Trias of St. Cassian. *T. lyra*, Sowb. (cxxxv, 34, 35). *T. neocomiensis*, d'Orb. (cxxxv, 36).

MEGERLIA King, 1850. (Muhlfeldtia, Bayle, 1880.) Loop trebly attached; to the hinge-plate by its crura, and to the septum by processes from the diverging and reflected portions of the loop. 3 sp. Mediterranean, Philippines. Fossil, 7 sp. Chalk—. *T. truncata*, Lam. (cxxxv. 37–39).

LAQUEUS, Dall, 1870. Shell with the reflected portion of the loop attached by slender processes, on each side, to the hæmal processes, at or near the points where the two septal processes

branch off to the septum; foramen complete. 2 sp. Cal., Japan. *T. Californica*, Koch (cxxxv, 40).

KINGENA, Davidson, 1852. Posterior part of the reflected portion of the loop broad, angulated, with the two angles bent down on each side and joined to the septum directly (not to the hæmal or septal processes), forming a broad ring, only intersected by the septum; exterior granulated; foramen entire. *T. lima*, Defrance (cxxxv, 43, 44). Cret.; Europe.

MAGAS, Sowb., 1816. (Mannia, Dewalque, 1874) Shell smooth, conspicuously punctate, dorsal valve impressed, foramen angular, deltidium rudimentary; internal septum prominent, touching the ventral valve; reflected portions of the loop disunited. 3 sp. U. Greensand—Chalk; Europe. Recent, 2 sp. New Zealand, Canaries. *T. pumila*, Sowb. (cxxxv, 48, 49).

RHYNCHORA, Dalm., 1828. Like Magas, but hinge-margin long, straight, the large valve with an area. Cretaceous. *T. costata*, Dalm.

MAGASELLA, Dall, 1870. Shell with the reflected portions of the apophyses united, forming a loop. Comprises most of the recent species of Magas. *T. Evansii*, Dav. 11 sp. N. Zealand.

ISMENIA, Gray, 1863. (Frenula, Dall, 1871.) Shell externally resembling Terebratella; apophyses broad and short, attached first by the septal process to a short stout septum, then recurved, the broad posterior edges of the reflected portion touching and blending with the septal processes and the adjacent part of the hæmal processes, forming a funnel-shaped ring, into which the septum does not project; the lateral loops of the apophyses remain open in the adult. Brachia without a median spiral lobe. Recent; *T. sanguinea*, Chemn. Fossil; *Ismenia pectunculus*, Gray. Oxford Clay; France.

Bouchardia, Davidson, 1849.

Distr.—2 sp. Brazil, 13 fathoms. *B. tulipa*, Blainv. (cxxxv, 45–47).

Beak prominent, with a minute apical foramen; deltidium blended with the shell; apophyses anchor-shaped, the septum being furnished with two short lamellæ.

Platidea, Costa, 1852.

Syn.—Morrisia, Davidson, 1852.

Distr.—3 sp. Mediterranean, W. Ind., Isle Bourbon. Fossil, 4 sp. Chalk—; Europe. *P. anomioides*, Scacchi (cxxxv, 50–52).

Shell minute, conspicuously punctate; foramen large, encroaching equally on both valves; hinge-area small, straight; loop not reflected, attached to a small forked process in the centre of the valve.

Animal with sigmoid arms, destitute of spiral terminations; cirri in pairs.

KRAUSSINA, Davidson, 1859.

Syn.—Kraussia, Davidson, not Dana, 1852.

Distr.—6 sp. South Africa, Sydney, New Zealand; low-water to 120 fathoms. *K. rubra*, Pallas (cxxxv, 53, 54).

Shell transversely oblong; hinge-line nearly straight; beak truncated, laterally keeled; area flat; foramen large, deltidium rudimentary; dorsal valve longitudinally impressed, furnished inside with a forked process rising nearly centrally from the septum; interior often strongly tuberculated. The apophyses are sometimes a little branched.

Animal with rather small oral arms, the spiral lobe very diminutive.

ARGIOPE, Eudes Deslongchamps, 1842.

Etym.—*Argiope*, a nymph. *Syn.*—Megathyris, d'Orb., 1847.

Distr.—5 sp. North Britain, Madeira, Canaries, Mediterranean; 30–105 fathoms. Fossil, 19 sp. Oolite—; Europe. *A. decollata*, Chemn. (cxxxvi, 60–63).

Shell minute, transversely oblong or semiovate, smooth or with corresponding ribs; hinge-line wide and straight, with a narrow area to each valve; foramen large, deltidium rudimentary; interior of dorsal valve with one or more prominent, submarginal septa; loop two- or four-lobed, adhering to the septa, and more or less confluent with the valve.

Animal with oral arms folded into two or four lobes, united by membrane, forming a brachial disk fringed with long cirri; mantle extending to the margins of the valves, closely adherent.

CISTELLA, Gray, 1853. (Zellania, Moore, 1855.) Shell minute orthiform; texture fibrous; hinge-area short, foramen angular, encroaching on both valves; interior of dorsal valve as in Thecidium, with a single central septum and broad margin. Recent, 7 sp. Fossil, 3 sp. Lias—Great Oolite; Britain. *A. Davidsoni*, Moore (cxxxvi, 64, 65).

FAMILY STRINGOCEPHALIDÆ.

Shell suborbicular, the hinge-margin rounded; the under valve with a deltidium and opening under the prominent beak; cardinal process very large, almost touching the opposite valve; loop attached to the crura by their neural edges.

STRINGOCEPHALUS, Defrance, 1824.

Etym.—*Strinx* (*stringos*), an owl; *cephale*, the head.

Distr.—*S. Burtini*, Defrance (cxxxvi, 55, 56, 66, 67). 2 sp. Silurian, Devonian; Europe.

Shell punctate; suborbicular, with a prominent beak; ventral

valve with a longitudinal septum in the middle: ... distinct; foramen large and angular in the young shell, ... surrounded by the deltidium, and rendered small and ... adult; deltidium composed of three elements: teeth ... dorsal valve depressed, cardinal process very prominent ... times touching the opposite valve, its extremity forked ... the ventral septum; hinge-plate supporting a shelly loo... the manner of Argiope.

CRYPTACANTHIA, White and St. John, 1868. "The loop ... to be essentially like that of Waldheimia in form, but ... of the loop appear to be joined, * * * and the loop ... armed with numerous spines which point outward tow... shell (?) in all directions." *S. compacta*, W. and St. J. Iowa.

FAMILY THECIDIIDÆ.

Shell (perforate when young?) attached by the ... when adult. Brachia lobed, not spiral. Shell articu... teeth, sockets and a cardinal process.

THECIDIA, Defrance, 1828.

Etym.—*Thekidion*, a small pouch.

Syn.—Bactrynium, Emmrich. Pterophloios, Gumbel ... -cidium, Sowb.

Distr.—2 sp. Mediterranean, W. Indies. Fossil ... Trias—; Europe. *T. papillata*, Schloth. (cxxxvi. 57-5...

Shell small, thick, punctate, attached by the beak ... flat; deltidium triangular, indistinct; dorsal valve ... depressed: interior with a broad granulated margin. ... process prominent, between the dental sockets: ... united, forming a bridge over the small and deep ... disk grooved for the reception of the loop, the groove ... by branches from a central septum; loop often ... lobed, and united more or less intimately with the ... grooves; ventral valve deeply excavated, hinge-teeth ... cavities for the adductor and pedicel muscles small, ...ed by two large, smooth impressions of the cardinal ... bordered by a vascular line.

Animal with elongated oral arms, folded on ... fringed with long cirri; mantle extending to the ... valves and closely adherent: epidermis distinct.

FAMILY RHYNCHONELLIDÆ.

... punctate, oblong, or trigonal, beaked: ... ... articulated, convex, often sharply ... ... beak, usually completed by a ... ... concealed: hinge-teeth supported by dental ...

plate deeply divided, supporting oral lamellæ, rarely provided with spiral processes; muscular impressions grouped as in Terebratula; vascular impressions consisting of two principal trunks in each valve, narrow, dichotomizing, angular, the principal posterior branches inclosing ovarian spaces.

Animal (of Rhynchonella) with elongated spiral arms, directed inwards, towards the concavity of the dorsal valve; alimentary canal terminating behind the insertion of the adductor in the ventral valve; mantle not adhering, its margin fringed with a few short setæ.

RHYNCHONELLA, Fischer, 1809.

Syn.—Hypothyris, Phil., 1841. Hemithyris, d'Orbigny, 1847. Cyclothyris, M'Coy, 1844. Trigonella (part), Fischer, 1809 (not L. nor Dacosta). Stenochisma, Hall (part), 1847. Rhyncotrema, Hall, 1860.

Distr.—6 sp. *R. psittacea*, Chemn. (cxxxvi, 69–71). Labrador (low-water?), Hudson's Bay (100 fathoms), Melville Island, Sitka, Icy Sea. *R. nigricans*, Sby. (cxxxvi, 72). New Zealand, 19 fathoms. Fossil, 500 sp. Lower Silurian—; North and South America, Europe, Thibet, China. *R. vespertilio*, d'Orb. (cxxxvi, 68).

Shell trigonal, acutely beaked, usually plaited; dorsal valve elevated in front, depressed at the sides; ventral valve flattened, or hollowed along the centre, hinge-plates supporting two slender curved lamellæ; dental plates diverging.

The foramen is at first only an angular notch in the hinge-line of the ventral valve, but the growth of the deltidium usually renders it complete in the adult shell; in the cretaceous species it is tubular. In *R. acuminata* (cxxxvi, 73, 74), and many other palæozoic examples, the beak is so closely incurved as to allow no space for a pedicel. Both the recent Rhynchonellæ are black; *R. octoplicata* of the Chalk sometimes retains six dark spots.

ACANTHOTHYRIS, d'Orb., 1850. Exterior surface spinous. *R. spinosa*, Schloth. (cxxxvi, 75). Jurassic.

RHYNCHOPORA, King, 1856. Valves having a punctate structure. *R. Geinitziana*, Vern. Dyas.

LEIORHYNCHUS, Hall, 1860. Proposed for forms marked by plications on the mesial fold and sinus, and sometimes with obscure or distinct plications on the lateral portions of the shell. 13 sp. Devonian; United States.

EATONIA, Hall, 1859.

Etym.—Dedicated to the late Professor Amos Eaton.

Syn.—Elonia, Meek and Worthen.

Distr.—Fossil, 7 sp. Upper Silurian; United States. *E. medialis*, Hall (cxxxvi, 76–79).

valve with a longitudinal septum in the middle; hinge-area distinct; foramen large and angular in the young shell, gradually surrounded by the deltidium, and rendered small and oval in the adult; deltidium composed of three elements; teeth prominent; dorsal valve depressed, cardinal process very prominent, sometimes touching the opposite valve, its extremity forked to receive the ventral septum; hinge-plate supporting a shelly loop, after the manner of Argiope.

CRYPTACANTHIA, White and St. John, 1868. "The loop seems to be essentially like that of Waldheimia in form, but the crura of the loop appear to be joined, * * * and the loop-band is armed with numerous spines which point outward toward the shell (?) in all directions." *S. compacta*, W. and St. J. Carb.; Iowa.

FAMILY THECIDIIDÆ.

Shell (perforate when young?) attached by the neural valve when adult. Brachia lobed, not spiral. Shell articulated by teeth, sockets and a cardinal process.

THECIDIA, Defrance, 1828.

Etym.—*Thekidion*, a small pouch.

Syn.—Bactrynium, Emmrich. Pterophloios, Gumbel. Thecidium, Sowb.

Distr.—2 sp. Mediterranean, W. Indies. Fossil, 34 sp. Trias—; Europe. *T. papillata*, Schloth. (cxxxvi, 57–59).

Shell small, thick, punctate, attached by the beak, hinge-area flat; deltidium triangular, indistinct; dorsal valve rounded, depressed: interior with a broad granulated margin; cardinal process prominent, between the dental sockets; oral processes united, forming a bridge over the small and deep visceral cavity; disk grooved for the reception of the loop, the grooves separated by branches from a central septum; loop often unsymmetrical, lobed, and united more or less intimately with the sides of the grooves; ventral valve deeply excavated, hinge-teeth prominent; cavities for the adductor and pedicel muscles small; disk occupied by two large, smooth impressions of the cardinal muscles, bordered by a vascular line.

Animal with elongated oral arms, folded on themselves and fringed with long cirri; mantle extending to the margin of the valves and closely adherent; epidermis distinct.

FAMILY RHYNCHONELLIDÆ.

Shell impunctate, oblong, or trigonal, beaked; hinge-line curved; no area; valves articulated, convex, often sharply plaited; foramen beneath the beak, usually completed by a deltidium, sometimes concealed; hinge-teeth supported by dental plates; hinge-

plate deeply divided, supporting oral lamellæ, rarely provided with spiral processes; muscular impressions grouped as in Terebratula; vascular impressions consisting of two principal trunks in each valve, narrow, dichotomizing, angular, the principal posterior branches inclosing ovarian spaces.

Animal (of Rhynchonella) with elongated spiral arms, directed inwards, towards the concavity of the dorsal valve; alimentary canal terminating behind the insertion of the adductor in the ventral valve; mantle not adhering, its margin fringed with a few short setæ.

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Syn.—Hypothyris, Phil., 1841. Hemithyris, d'Orbigny, 1847. Cyclothyris, M'Coy, 1844. Trigonella (part), Fischer, 1809 (not L. nor Dacosta). Stenochisma, Hall (part), 1847. Rhyncotrema, Hall, 1860.

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ACANTHOTHYRIS, d'Orb., 1850. Exterior surface spinous. *R. spinosa*, Schloth. (cxxxvi, 75). Jurassic.

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LEIORHYNCHUS, Hall, 1860. Proposed for forms marked by plications on the mesial fold and sinus, and sometimes with obscure or distinct plications on the lateral portions of the shell. 13 sp. Devonian; United States.

EATONIA, Hall, 1859.

Etym.—Dedicated to the late Professor Amos Eaton.

Syn.—Elonia, Meek and Worthen.

Distr.—Fossil, 7 sp. Upper Silurian; United States. *E. medialis*, Hall (cxxxvi, 76–79).

Shell like that of Rhynchonella; the lower half of the ventral valve with a broad, deep sinus. Valves articulating by means of two teeth in the ventral valve, with corresponding sockets in the dorsal valve, and a median septum embraced between the deeply bifurcating cardinal process of the opposite one.

Dorsal valve with four crural processes; in the ventral valve the dental plates are represented by elevated lamellæ surrounding the muscular impression, which is much stronger and differs in some respects from that of Rhynchonella.

Dimerella, Zittel, 1870.

Syn.—Cryptopora, Jeffreys, 1869. Atretia, Jeffreys, 1876.

Distr.—Recent. *D. gnomon*, Jeffreys. Europe. Fossil; Triassic.

Shell small, Rhynchonelloid, impunctate, with a large foramen; neural valve with an entire edge without a septum; hæmal valve with a large, very prominent septum, which divides the cavity of the shell, when closed, into two chambers; with two stout, diverging hook-shaped crura as in Rhynchonella.

Rhynchonellina, Gemellaro, 1871.

Distr.—4 sp. Jurassic; Sicily. *R. Suessi*, Gemm.

Shell quadrangular or triangular, smooth or radially ribbed, hinge-margin nearly straight; large valve swollen, with curved beak, a large triangular area, with a rudimentary deltidium and oval opening; teeth and pits as in Rhynchonella; upper valve less swollen or flattish, with two very long crura, almost reaching the opposite valve, these crura sometimes provided, near the hinge, with sickle-shaped processes.

Stricklandinia, Billings, 1863.

Etym.—Dedicated to the late Professor H. E. Strickland.

Syn.—Stricklandia, Billings, 1859 (non Buckman). Rensselæria (pars), Hall, 1859.

Distr.—10 sp. Silurian; N. America, England. *S. elongata*, Vanuxem, is the only species known in the Devonian rocks. *S. lens*, Billings (cxxxvi, 80. 81).

Shell usually large, elongate-oval, etc.; valves nearly equal, never globose; a short mesial septum in the interior of the ventral valve supporting a small triangular chamber beneath the beak as in Pentamerus; in the dorsal valve no longitudinal septa, spires, or loop, the whole of the internal solid organs consisting of two short or rudimentary dental plates, which in some species bear prolonged calcified processes for the support of the cirrated arms. A more or less developed area in the ventral valve.

In *S. lævis* and *S. microcamerus* the hinge-line is straight and much extended. In *S. Arachne*, Billings, the area of the ventral

valve is so much developed as to give the whole shell the external appearance of an Orthis.

CAMERELLA, Billings, 1859.

Syn.—Triplesia, Hall, 1859.

Distr.—9 sp. Lower Silurian; North America. *C. Volborthi*, Billings.

Ventral valve with a small triangular chamber beneath the beak, supported by a short mesial septum as in Pentamerus. Dorsal valve with a single mesial septum and two short lamellæ for the support of the oral appendages, as in Rhynchonella. Surface smooth or obscurely plicated.

EICHWALDIA, Billings, 1858.

Etym.—Dedicated to Professor Eichwald, the celebrated Russian palæontologist.

Distr.—3 sp. Silurian; Canada, England. *E. subtrigonalis*, Billings.

Shell with the ventral valve perforated on the umbo for the passage of a peduncle; the place of the foramen beneath the beak being occupied by an imperforate concave plate; the interior of each valve divided by a medio-longitudinal ridge, that of the dorsal valve very prominent; hinge and teeth sockets wanting.

The internal structure of the ventral valve somewhat resembles that of Pentamerus or Camarophoria.

CAMAROPHORIA, King, 1844.

Distr.—Fossil, 9 sp. Carb.—Permian (Magnesian limestone); Germany and England, N. America. *C. Schlotheimi*, Busch (cxxxvi, 82). *C. crumena*, Martin (cxxxvi, 83, 84).

Ventral valve with converging dental plates supported on a low septal ridge; dorsal valve with a prominent septum supporting a spoon-shaped central process; oral lamellæ long and slender. Foramen angular, cardinal process distinct.

PENTAMERUS, Sowerby, 1813.

Etym.—*Pentameres*, five-partite.

Distr.—Fossil, 52 sp. Upper Silurian—Devonian; Arctic America, United States, Europe. *P. Knightii*, Sby. (cxxxvi, 85–87).

Shell impunctate, ovate, ventricose, with a large incurved beak; valves usually plaited; foramen angular; no area or deltidium; dental plates converging, trough-like, supported on a prominent septum; dorsal valve with two contiguous longitudinal septa opposed to the plates of the other valve.

Oral lamellæ have been detected by Mr. Salter in *P. liratus*;

in *P.* ? *brevirostris* (Devonian, Newton) the dorsal valve has a long trough-like process supported by a single low septum.

GYPIDIA, Dalman, 1828. *P. conchidium*, Dalm. Gotland. U. Silurian.

PENTAMERELLA, Hall, 1867. Ovately rounded, with a sinus on the ventral and a mesial fold on the dorsal valve; dorsal valve with the crura conjoined so as to form a separate trough-shaped cavity, which unites with the inner surface of the valve; a narrow area on each side of the fissure, and a flattened space or false area along the cardinal margin of the valve. Devonian; N. Am. *P. arata*, Conr.

GYPIDULA, Hall, 1867. Short, gibbous or ventricose; ventral valve much the larger, with or without mesial fold, a large fissure, and elongate, much incurved, trough-shaped pit; dorsal valve depressed in front; an area on both valves, that of the ventral valve striate, as in Spirifera; lamellæ of dorsal valve separate and diverging. Devonian; North America. *P. occidentalis*, Hall.

ANASTROPHIA, Hall, 1867. (Brachymerus, Shaler, 1865, preoc. Coleopt.) Rotund or gibbous, with the valves, as in ordinary Pentamerus, reversed; ventral valve smaller, gibbous in its upper part, depressed or sinuate below, with the V-shaped pit sessile for nearly its entire length; a small flattened space on each side of the fissure; dorsal valve ventricose, larger than the ventral, with prominent umbo; hinge-plate extended in gradually converging vertical lamellæ, which are joined to the shell throughout their length, whilst the crura are extended into the cavity in thin, free lamellæ. Silurian; North America. *P. Verneuili*, Hall.

AMPHIGENIA, Hall, 1867. Elongate, not lobed, ventral valve with connected dental lamellæ, forming a trough supported on a septum; dorsal valve with free crura; no area; shell-structure punctate. *P. elongata*, Vanuxem. Devon.; U. S.

? CLORINDA, Barrande. Silurian; Bohemia.

FAMILY ATRYPIDÆ.

Shell fibrous; beak curved; hinge-margin curved, with strong teeth, without area; dorsal valve with two spirally coiled lamellæ, the points directed towards the middle of the opposite valve.

ATRYPA, Dalman, 1828.

Syn.—Cleiothyris, Phillips, 1841. Spirigerina, d'Orb., 1847.

Distr.—Fossil, 21 sp. Lower Silurian—Trias; America (Wellington Channel! Falkland Islands), Europe, Thibet. *A. reticularis*, Linn. (cxxxvi, 88–91).

Shell impunctate; oval, usually plaited and ornamented with squamose lines of growth; dorsal valve gibbose; ventral

depressed in front; beak small, often closely incurved; foramen round, sometimes completed by a deltidium, often concealed; dorsal valve with a divided hinge-plate, supporting two broad spirally coiled lamellæ; spires vertical, closely appressed, and directed towards the centre of the valve; teeth and impressions like Rhynchonella.

The shells of this genus differ from Rhynchonella chiefly in the calcification of the oral supports, a character of uncertain value.

The internal appendages of *Atrypa reticularis* consist of a pair of spiral cones, placed side by side, with their apices directed towards the cavity of the dorsal valve; the lamellæ have their origin on the socket-walls, and run parallel with the inner margin of the valve. "The spiral cones are connected by an entire and continuous loop, which is confined to the rostral part of the shell. The loop arises from the posterior portion of the first volutions of the spires, and curves gently forward and upward; the central or elevated portion is situated between and behind the cones, and forms a more or less abrupt curve, or is prolonged into a point directed towards the dorsal valve. The existence and form of this loop have been ascertained in several different varieties of *A. reticularis*, as well as in *A. spinosa*, Hall."—WHITFIELD.

CŒLOSPIRA, Hall, 1863. Shell fibrous, concavo-convex; spiral lamellæ with their bases turned towards the ventral, their points towards the dorsal valve. *A. camilla*, Hall (cxxxvii, 92).

STENOSCHISMA, Hall, 1847. (Zygospira, Hall, 1862.) Spiral cones connected by an entire and continuous loop in a very similar manner to that shown to exist in *Atrypa reticularis*; but the loop having its connection with the spiral lamellæ at a point relatively more distant from their origin on the hinge-plate, and passing over or in front of the spires. *A. modesta*, Say. Silurian; U. S.

GLASSIA, Davidson, 1881.

Distr.—3 sp. Silurian; England. *G. Whidbornei*, Davidson (cxxxvii, 93).

Principal lamellæ, forming the first coils of the spirals, connected at a short distance from the attachment to the hinge-plate by a ribbon-shaped lamella or loop; this loop, commencing on each side from the principal lamellæ, converges downwards in the shape of the letter V; principal coils of the spirals directly face the lateral margins; the ends of the spirals meet each other in the centre of the shell; each spiral consists of four coils.

ANAZYGA, Davidson, 1882.

Distr.—*A. recurvirostra*, Hall (cxxxvii, 94). Trenton limestone, Canada.

Shell small, longitudinally oval, radiately striated; position

of the spiral cones in the type same as in Zygospira, the base of each spiral cone being obliquely inclined towards the bottom and sides of the ventral valve; there are about four coils in each spiral cone; the primary stems of the spirals are attached to the hinge-plate of the dorsal valve; and after extending parallel to each other for a short distance, they bend at right-angles abruptly towards the lateral portions of the beak, and form two large curves facing the lateral portions of the valve; just before reaching their furthest extension in front they give off a semicircular band or loop, which is directed upwards towards the beak, and is exterior to the spiral cones on their dorsal side.

FAMILY SPIRIFERIDÆ.

Shell furnished internally with two calcareous spiral processes (apophyses) directed outwards towards the sides of the shell, and destined for the support of the oral arms, which must have been fixed immovably; the spiral lamellæ are sometimes spinulose, indicating the existence of rigid cirri, especially on the front of the whorls; valves articulated by teeth and sockets.

SPIRIFER, Sowerby, 1815.

Syn.—Trigonotreta, König, 1825. Choristites, Fischer, 1825. Delthyris, Dalman, 1828. Fusula, Reticularia, Brachythyris, M'Coy, 1844.

Distr.—300 sp. Lower Silurian—Trias; Arctic America—Chili, Falkland Islands, Europe, China, Thibet, Australia, Tasmania. In China these and other fossils are used as medicine. *S. striatus*, Mart. (cxxxvii, 95, 96). *S. Wolcotti*, Sowerby (cxxxvii, 97).

Shell transversely oval or elongated, trilobed, beaked, biconvex, with a dorsal ridge and ventral furrow; hinge-line wide and straight; area moderate, striated across; foramen angular, open in the young, afterwards progressively closed; ventral valve with prominent hinge-teeth, and a central muscular scar, consisting of the single adductor flanked by two cardinal impressions; dorsal valve with a small cardinal process, a divided hinge-plate, and two conical spires directed outwards and nearly filling the cavity of the shell; crura united by an oral loop. The shell and spires are sometimes silicified in limestone, and may be developed by means of acid. In *S. mosquensis* the dental plates are prolonged nearly to the front of the ventral valve.

SPIRIFERINA, d'Orbigny, 1847. (Mentzelia, Quenst., 1871.) Shell punctate, external surface spinulose; foramen covered by a pseudo-deltidium; interior of ventral valve with a prominent septum, rising from the adductor scar. 29 sp. Carb.—Lower Oolites; Britain, France, Germany, South America. *S. rostrata*, Schloth. (cxxxvii, 98-100).

CYRTIA, Dalman, 1828. Shell impunctate, pyramidal, beak prominent, area equiangular, deltidium with a small tubular foramen. Fossil, 10 sp. Silurian—Trias; Europe. *S. trapezoidalis*, Dalman (cxxxvii, 3).

MARTINIA, M'Coy, 1844. (Ambocœlia, Hall, 1860.) Dorsal margin shorter than the width of the shell, the angles of the hinge-margin shortly rounded; surface smooth; spiral lamellæ small. Silur.—Carb.; Eur., U. S. *S. glaber*, Sowb.

SUESSIA, Deslongchamps, 1855. (Dedicated to M. Suess.) Shell like Spirifer; texture fibrous; hinge-area wide as the shell; foramen deltoid; large valve with two cardinal septa, and a prominent central septum, supporting a little plate; small valve with a trilobed cardinal process, and a broad four-partite hinge-plate, with processes from the outer angles of the dental sockets; crura of the spires united by a transverse band supporting a small process. Fossil, 2 sp. Upper Lias; Normandy. *S. imbricata*, Desl. (cxxxvii, 1, 2).

SYRINGOTHYRIS, Winchell, 1863. Shell like that of Spirifer, with an elongated hinge-line. Ventral valve with a broad mesial sinus, a very broad area, and a narrow triangular fissure closed towards the apex by an external convex pseudo-deltidium; beneath which, and diverging from it, is another transverse plate connecting the vertical dental lamellæ, which are incurved so as to nearly join their inferior edges, thus forming a fissured tube, which projects beyond the limits of the plate from which it originates into the interior of the shell. A low median ridge extends from the beak to the anterior part of the valve. Dorsal valve depressed, without an area, and with a distinct mesial fold. Shell-structure punctate. Fossil, 2 sp. Carboniferous; United States, Ireland, Belgium. *S. typa*, Winchell (cxxxvii, 6). "Is it not an abnormal Spirifer or Cyrtia?"—MEEK.

CYRTINA, Davidson, 1858. (*Etym.*—Modified from the diminutive [*Cyrtidium*] of Cyrtia.) Shell resembling Spirifer, but without the vertical shelly plates which diverge from the extremity of the beak. Interior of ventral valve with two contiguous vertical septa, which coalesce into one median plate, which extends from the extremity of the beak to within a short distance of the frontal margin, and then diverges to form dental plates, as in Pentamerus. The fissure is covered by an arch-shaped deltidium; but in *C. Demarlii* the median septum is continued as far as the under surface of the deltidium, and the dental plates are fixed to the sides, instead of the upper edge, as in *C. heteroclita* and *C. septosa*. "Spiral coils having the same position as in Spirifer, but the first two coils are connected a little in front of the mid-length by an apparatus somewhat like that of Spirigera, but not so complicated. A very slender process springs upwards towards the central valve from each coil, and,

at a height of about one line, curves forward. The two then unite and form a single band, which extends forwards to about the front of the coil, and there ends in an obtuse point."—BILLINGS. 9 sp. Silurian, Devonian—Trias; Europe and North America. *S. heteroclita*, Defrance cxxxvii, 4, 5.

MIMULUS, Barr. Shell like Spirifer, but the smaller valve with a sinus, the larger one with a saddle; interior unknown. *S. perversa*, Barr. Silurian; Bohemia.

ATHYRIS, M'Coy, 1844.

Etym.—*A*, without; *thuris*, a door (*i. e.* deltidium).

Syn.—Spirigera, d'Orbigny, 1847. Cleiothyris, King (not Phil.), 1850. Euthyris, Quenst., 1871. Actinoconchus, M'Coy, 1844.

Distr.—Fossil, about 100 sp. Silurian—Lias; N. and S. America and Europe. *A. lamellosa*, Lev. (cxxxvii, 7). *A. Roissyi* (cxxxvii, 8, 9).

Shell impunctate, transversely oval, or suborbicular, biconvex, smooth, or ornamented with squamose lines of growth, sometimes developed into wing-like expansions; hinge-line curved, area obsolete, foramen round, truncating the beak, deltidium obsolete; hinge-plate of dorsal valve with four muscular cavities, perforated by a small round foramen, and supporting a small complicated loop (?) between the spires; spires directed outwards, crura united by a prominent oral loop.

The foramen in the hinge-plate occupies the situation of the notch through which the intestine passes in the recent Rhynchonellæ; in *A. concentrica* a slender curved tube is sometimes attached to the foramen, beneath the hinge-plate. *A. tumida* has the hinge-plate merely grooved, and the byssal foramen is angular.

KAYSERIA, Davidson, 1882.

Etym.—Named after E. Kayser, a German palæontologist.

Distr.—*K. lens*, Phil. (cxxxvii, 10–12).

Distinguished from Athyris by its prominent dorsal septum and its connection with the loop, the shape and direction of the curved lamellæ composing the commencement of the loop, and the rounded process by which these lamellæ are continued, as well as the long extension of the accessory lamellæ.

The continuation of the accessory lamellæ from their commencement at the loop to the end of the spiral is especially notable. In Meristina there is a simple loop; in Whitfieldia this loop is continued by a bifurcation; this bifurcation is still further continued in Athyris; whilst in the species under consideration the lamellæ arising from the end of the loop are extended throughout the whole length of the spiral.

CHARIONELLA, Billings, 1861.

Syn.—Cryptonella, Hall, 1861.

Distr.—15 sp. Devonian; America, Spain. *C. scitula*, Hall.

Shell resembling Athyris, but more elongate-ovate or approaching to Terebratula in form. Internal spires as in Athyris and Merista, but the dorsal hinge-plate is either obsolete along the middle, or anchylosed to the bottom of the valve. Foramen terminal, bounded on the lower side by one or two deltidial pieces, or by a portion of the shell. The mesial septum in the dorsal valve is either absent or rudimentary.

NUCLEOSPIRA, Hall, 1859.

Etym.—*Nucleus*, and *spira*.

Distr.—7 sp. Silurian, Devonian; United States, England. *N. ventricosa*, Hall (cxxxviii, 16–18).

Shell punctate; spheroidal; beaked; hinge-line shorter than the width of the shell; cardinal extremities rounded. Internal spires as in Spirifera. Ventral valve with a flattened space or false area beneath the beak, on each side of which, at the base, is a strong tooth; a narrow medio-longitudinal septum extends from the beak to the base. Dorsal valve furnished with a strong spatulate cardinal process, which, rising vertically from the cardinal margin, is closely grasped at its base by the cardinal teeth of the other valve; and thence bending abruptly upwards, and expanding, is projected into the cavity of the opposite beak, lying close upon the under side of the false area. Cardinal process grooved to allow of the passage of the peduncle, for the protrusion of which a minute foramen is sometimes observed in the beak. The crural processes originate at the base of the cardinal process. A medio-longitudinal septum as in the ventral valve.

Surface of shell apparently smooth, under a lens punctate; when perfect, covered with minute hair-like spines.

The larger species of this genus present some analogy in external appearance with Spirigera, and the presence of internal spires increases the similarity. The cardinal teeth resemble those of Spirigera and Merista. In form, and in the punctated test, it simulates Magas; while the elongate cardinal process of the dorsal valve resembles that structure in Thecidium.

MERISTA, Suess, 1851.

Syn.—Camarium, Hall, 1859.

Distr.—Silurian—Devonian; Europe, N. Am. *M. herculea*, Desl. (cxxxviii, 19).

Shell impunctate, dental plates and dorsal septum supported by arched plates ("shoe-lifter" processes, of King) which readily

detach, leaving cavities; spiral arms have been observed in all the species.

MERISTELLA, Hall, 1860. (Pentagonia, Cozzens ? 1846. Gonioccelia, Hall, 1861.) Shell oval, ovoid, orbicular or transverse. Valves unequally convex, with or without a median fold and sinus; beak apparently imperforate, incurved; area none. Surface smooth or concentrically striated. Dorsal valve with a longitudinal septum; upper part of the ventral valve with a deep subtriangular muscular impression which unites with the rostral cavity. The species of this group are Meristæ without the peculiar appendage of the ventral valve. 17 sp. Silurian—Devonian; Europe, N. Am. *M tumida*, Dalm. (cxxxviii, 20).

MERISTINA, Hall, 1867. Spirals of more simple character than in the typical group. *M. nitida*, Hall. Upper Silurian.

WHITFIELDIA, Davidson, 1881. End of loop bifurcated. Sil.; Europe, America. *M. tumida*, Dalm. (cxxxvii, 14).

BIFIDA, Davidson, 1882.

Distr.—2 sp. Devonian; Europe. *B. lepida*, Goldfuss (cxxxvii, 13).

Resembles Whitfieldia in the shape and position of the spirals and in the attachments to the hinge-plate, only the spirals of Bifida are slightly depressed or flattened on their dorsal side; there are usually four coils in each spiral; the loop is like that in Meristina, with the exception that it is placed nearer to the attachments to the hinge-plate, and that at the point where the two lamellæ composing the loop join there is a short bifurcation directed upwards, as in Whitfieldia.

RETZIA, King, 1850.

Etym.—Dedicated to the distinguished Swedish naturalist, Retzius.

Syn.—Trigeria, Bayle.

Distr.—Fossil, about 50 sp. Silurian—Trias; So. America, United States, Europe. *R. trigonella*, Schloth. (cxxxviii, 21-23).

Shell punctate, Terebratula-shaped; beak truncated by a round foramen, rendered complete by a distinct deltidium; hinge-area small, triangular, sharply defined; interior with diverging shelly spires.

Professor King first pointed out the existence of calcareous spires in several Terebratulæ of the older rocks, and others have been discovered by MM. Quenstedt, De Koninck, and Barrande. In form they resemble Terebratulina, Eudesia, and Lyra.

TREMATOSPIRA, Hall, 1859. (*Etym.*—*Trema*, a foramen, and *spira*.) Shell transverse, elliptical, or subrhomboidal, furnished with internal spires (arranged as in Spirifer); hinge-line shorter than the width of the shell. Valves articulated by teeth and sockets; beak of ventral valve produced or incurved and trun-

cated by a small round perforation separated from the hinge-line by a deltidium. A deep triangular pit or foramen beneath the beak, which is filled by the closely incurved beak of the dorsal valve. False areas sometimes defined. 7 sp. Upper Silurian—Middle Devonian; United States. *R. hirsuta*, Hall (cxxxviii, 24–27).

RHYNCHOSPIRA, Hall, 1859. (*Etym.*—ῥύγχος, a beak, and *spira*; in allusion to its similarity in form to Rhynchonella, and having internal spires.) Shell somewhat similar to Rhynchonella, but usually more symmetrically rounded, and with less distinct mesial sinuosities; and in these characters they resemble Waldheimia. Valves articulated by teeth and sockets, similar to those of Nucleospira; the crura supporting two conical spires. The cardinal process of the dorsal valve is a broad emarginate plate; beak of the ventral valve largely perforated. Surface plicated or striated. 7 sp. Silurian—Devonian; United States, Russia. *R. formosa*, Hall.

ACAMBONA, White, 1862.

Syn.—Eumetria, Hall, 1864.

Distr.—*A. prima*, White (cxxxviii, 30). Carb.; U. S.

Shell resembling Retzia externally, furnished with internal spires, pointing outward and downward? beak of ventral valve prominent, incurved, pointed; area emarginate in front, or V-shaped, reaching to the point of the beak, and extending forward of the beak of the dorsal valve on each side of it; beak of dorsal valve closely incurved, filling or nearly filling the forked space or emargination in the front part of the area, being itself without angular winged extensions or area, to meet that of the opposite valve; shell-structure punctate.

Differs from Retzia in having a pointed ventral beak, curved hinge-line, and no angular cardinal wings on the dorsal valve; from Uncites in having an area and punctate structure; from Trematospira in its pointed ventral beak and true area.

DAYIA, Davidson, 1881.

Distr.—*D. navicula*, Sowb. (cxxxviii, 28, 29). Silurian; England.

Oval, broadest posteriorly; ventral valve very convex, keeled along the middle, beak closely incurved, dorsal valve slightly convex posteriorly, anterior half of shell concave, surface smooth; in the interior of the dorsal valve a slightly raised ridge extends from under the hinge-plate to about half the length of the valve, and on either side are the two adductor scars; the sockets are widely separate; primary stems of the spirals extend parallel to each other for a short distance, bend at right-angles abruptly towards the lateral portions of the beak,

and form two large curves facing the lateral portions of the valve; on approaching the front they form four or five convolutions, which become smaller to the terminal coil, which faces the middle of the lateral portions of the shell; near the front the primary lamellæ give off two processes which converge and extend between the spiral coils in an upward and backward direction; after becoming united towards the middle of the shell, they are again prolonged in the shape of a single lamella, which proceeds upwards for a little distance with its extremity directed towards the hinge-plate. In the interior of the ventral valve a mesial groove extends to about the middle of the shell, and on either side, running parallel with the hinge-line, are two broad, rounded projections, at the outer extremity of which is situated the articulating tooth; below these are the elevated muscular scars.

HINDELLA, Davidson, 1882.

Distr.—*H. umbonella*, Billings (cxxxvii, 15). Palæozoic; Anticosti.

Shell elongate ovate; spiral cones with their apices directed towards the lateral margins of the shell; about six coils in each spiral; two principal stems of the spiral cones attached to the hinge-plate, and after extending a little way into the interior of the shell between the spirals, suddenly bent backwards towards the hinge; they then form a broad, rounded curve, facing the bottom of the dorsal valve, the curve being very gentle, so that the two primary lamellæ on the dorsal side seem almost like parallel lines; when the primary lamellæ reach the front they give off a semicircular band or loop having a projection or spike-like process at the top of it; this loop is directed upwards towards the beak, and is almost immediately behind the two primary lamellæ on the dorsal side of the spirals; the loop is therefore internal to the spirals.

UNCITES, Defrance, 1826.

Distr.—Fossil. Devonian; Europe. *U. gryphus*, Schloth. (cxxxviii, 31, 32).

Shell impunctate; oval, biconvex, with a long incurved beak; foramen apical, closed at an early age; deltidium large, concave; spiral processes directed outwards; no hinge-area.

The large, concave deltidium of Uncites so much resembles the channel formed by the dental plates of Pentamerus, that Dalman mistook the shell for a member of that genus. The discovery of internal spires, by Professor Beyrich, shows that it only differs from Retzia in being impunctate and destitute of hinge-area. Some of the specimens have corresponding depressions in the sides of the valves, forming pouches which do not communicate with the interior.

FAMILY KONINCKINIDÆ.

Shell small, concavo-convex; hinge-margin straight or curved, without area; no foramen; spiral lamellæ with their apices directed towards the large valve.

KONINCKINA, Suess, 1853.

Distr.—Triassic; U. S. *K. Leonhardi*, Wissm. (cxxxviii, 33–36).

Shell orbicular, concavo-convex, smooth; valves articulated? closely appressed; ventral valve convex, dorsal concave; beak incurved, no hinge-area nor foramen; interior of each valve furrowed by two spiral lines of four volutions, directed inwards, and crossing the vascular impressions; umbo with three diverging ridges. The small spiral cavities, once occupied by the arms, and now filled with spar, may be seen in specimens with both valves, by holding them to the light. M. Suess, of Vienna, states that he has found traces of very slender spiral lamellæ occupying the furrows.

ANOPLOTHECA, Sandberger, 1856.

Distr.—Devonian; Europe. *A. venusta*, Schnur.

Shell fibrous, concavo-convex, without foramen, area or deltidium; hinge-margin curved; large valve convex, with two teeth and a median septum which is anteriorly cleft, and on either side of which are the muscular impressions; smaller valve not so deep, with cleft hinge-process, and close to it the lamellæ, to which the spirals were attached.

THECOSPIRA, Zugmayer, 1880.

Distr.—Rhætian. *T. Haidingeri*, Suess.

Shell like Thecidium, but with spirals within, similar to those of Koninckina, the axes diverging towards the large valve, the bases roof-like over the small valve.

FAMILY STROPHOMENIDÆ.

Shell transversely oblong, depressed, rarely foraminated; hinge-line wide and straight; beaks inconspicuous; valves plano-convex, or concavo-convex, each with a hinge-area notched in the centre; ventral valve with prominent teeth; muscular impressions occupying a saucer-shaped cavity with a raised margin; adductor central; cardinal and pedicel impressions conjoined, lateral, fan-like; dorsal valve with a tooth-like cardinal process between two curved brachial processes; adductor impression quadruple; vascular impressions consisting of six principal

trunks in the dorsal valve, two in the ventral, the external branches turned outwards and backwards, inclosing wide ovarian spaces. Indications have been observed, in several genera, of horizontally coiled spiral arms; the space between the valves is often very small. The shell-structure is punctate, except in a few instances, where the original texture is probably obliterated.

ORTHIS, Dalman, 1827.

Etym.—*Orthos*, straight.

Syn.—Orthambonites, Pander, 1830. Schizophoria, King, 1850.

Distr.—Fossil, 300 sp. Lower Silurian—Carb.; Arctic Am., United States, South America, Falkland Islands, Europe, Thibet. *O. striatula*, Schloth. (cxxxviii, 37–39).

Shell transversely oblong, radiately striated or plaited, biconvex, hinge-line narrower than the shell, cardinal process simple, brachial processes tooth-like, prominent and curved.

BILOBITES, Linn., 1775. (Dicœlosia, King, 1850.) Ventral margin deeply cut out in the middle, forming two lobes in each valve; two strong curved crural processes from the hinge-margin of the smaller valve. Silurian; Gotland and U. S. *O. biloba*, Linn.

PLATYSTROPHIA, King, 1850. Shell somewhat transverse, nearly equivalve, with a long, straight hinge-line; both valves very convex, radially ribbed, with an area and trigonal deltidial opening; beaks curved, approaching; large valve with a deep median sinus. Silurian, Carboniferous. *O. lynx*, Eichw. (cxxxviii, 40).

ENTELETES, Fischer, 1830. (Choristites, Fischer [part], 1825.) Like Platystrophia, but the hinge-margin short; surface coarsely wrinkled, and finely radially sculptured. *O. Lamarcki*, Fischer. Carboniferous; Russia.

MYSTROPHORA, Kayser, 1871. Shell like Orthis, but the small valve with a very high median septum, which reaches to the other valve, and so divides the closed shell into two chambers; the two tooth-plates are united to the septum. Silurian, Devonian. *O. Lewisii*, Davids. Davidson makes this a synonym of Skenidium, Hall.

STREPTORHYNCHUS, King, 1850.

Etym.—*Strepto*, I bend or twist; *rhynchos*, a beak.

Syn.—Hipparionix, Vanuxem, 1842. Orthotetes (Evans), Fisch. (part), 1829.

Distr.—6 sp. Sil.—Perm.; Europe, Asia, America, and Australia. *S. Devonica*, d'Orb.

Shell inequivalved, convex or concavo-convex, externally striated; hinge-line rather shorter than the width of the shell; dorsal valve semicircular, with a small narrow area. Ventral

valve with a prolonged and oftentimes bent beak; area triangular, with a fissure covered by a convex pseudo-deltidium. No foramen is observable, but the cardinal process is at times seen partially extending under the deltidium.

Interior of ventral valve, with a strong hinge-work on either side at the base of the fissure, supported by a dental plate; muscular scars two, elongated, oval, deeply excavated, separated by a wide mesial ridge.

Interior of dorsal valve with a largely developed cardinal process, composed of two projections, grooved or bidentated towards the extremity of their outer surface; socket-plates large, and partly united to the lower portion of the cardinal process; adductor scars quadruple, occupying more than a third of the length of the valve, and arranged in pairs, divided by a short rounded mesial ridge.

This genus is intermediate between Orthis and Strophomena.

MEEKELLA, White and St. John, 1870. Ventral valve without septum, with two broad dental lamellæ which are continuous from the cardinal teeth to the beak, passing directly in front of the sutures between the cardinal area and the pseudo-deltidium, and thence slightly diverging, they extend forward along the bottom of the valve about half-way to the front, the anterior margins of the lamellæ arching backward and upward to the dental processes; in the rear of the hinge-line are three chambers, not communicating together, but all opening into the shell. Dorsal valve with long cardinal process, curving backward in front of the pseudo-deltidium, which has a wing-like expansion on each side of it, curved up at its outer edge to form the elongated dental fosset for the reception of the process of the opposite valve. Muscular markings unknown: outer surface apparently punctate. Carboniferous; U. S. *S. striatocostatus*, Cox.

ORTHISINA, d'Orb., 1847.

Syn.—Klitambonites (part), Pronites, Hemipronites, Gonambonites, Pander, 1830.

Distr.—Fossil. Lower Silurian; Europe. *O. anomala*, Schloth. (cxxxviii, 41, 42).

Shell impunctate? widest at the hinge-line; cardinal notch closed, byssal notch (fissure) covered by a convex pseudo-deltidium, sometimes perforated by a small round foramen.

SKENIDIUM, Hall, 1861. (*Etym.*—*Skenidion*, a little tent.) Shell having the general aspect of Orthis, except in the extreme elevation of the ventral valve; cardinal process prolonged into a median septum, which extends to the base or front margin of the shell, and occasionally bifurcates at this lower extremity. Area large and triangular in the typical species. 3 sp. Silur.; United States. *O. insignis*, Hall.

TROPIDOLEPTUS, Hall, 1859.

Etym.—*Tropis*, a keel, and *leptos*, thin; the carinated ventral valve and shallow visceral cavity, in its analogy with Leptæna.

Distr.—2 sp. Silurian; United States. *Strophomena carinata*, Conrad (cxxxviii, 43, 44).

Shell transversely oval, or longitudinally semielliptical, articulating by teeth and sockets, hinge-line about equal to the breadth of the shell. Ventral valve convex, with a linear area and triangular foramen in the margin of the area; from the inner edges of this proceed the dental lamellæ, which are separated from the area by a narrow groove strongly crenulated on the outer edge, and extending obliquely outwards, terminating in a low ridge which partially surrounds the muscular impression; dorsal valve concave; cardinal process prominent, wedge-shaped, supporting the bases of the crura; dental fossets crenulated, surface plicated; shell-structure punctated.

VITULINA, Hall, 1861.

Etym.—*Vitula*, a goddess.

Distr.—Devonian; New York. *V. pustulosa*, Hall (cxxxviii, 45–48).

Shell resembles that of Tropidoleptus, but the dental processes are not crenulated, nor distinctly separated from the area as in that genus.

STROPHOMENA, Rafinesque, 1827.

Etym.—*Strophos*, bent; *mene*, crescent.

Syn.—Peridiolithus, Hüpsch, 1768. Brachyprion, Shaler, 1869. Leptæna, Dalman, 1828.

Distr.—Fossil, 129 sp. Lower Silurian—Carb.; N. America, Europe, Thibet. *S. alternata*, Conr. (cxxxviii, 49, 50).

Shell semicircular, widest at the hinge-line, concavo-convex, depressed, radiately striated; area double; ventral valve with an angular notch, progressively covered by a convex pseudo-deltidium; umbo depressed, rarely (?) perforated, in young shells, by a minute foramen; muscular depressions four, central pair narrow, formed by the adductor; external pair fan-like, left by the cardinal and pedicel-muscles; dorsal valve with a bilobed cardinal process, between the dental sockets, and four depressions for the adductor muscles.

There are no apparent brachial processes in the dorsal valve of Strophomena, and it is possible that the spiral arms may have been supported at some point near the centre of the shell as in Productus; *S. rhomboidalis* occasionally exhibits traces of spiral arms, in the ventral valve. *S. latissima*, Bouch., has plain areas, like Calceola.

The valves of the Strophomenas are nearly flat until they

approach their full growth, they then bend abruptly to one side; the dorsal valve becomes concave in *S. alternata* and *rhomboidalis*, whilst in *S. planumbona* and *euglypha* it becomes convex; these distinctions are not even subgeneric.

STROPHODONTA, Hall, 1850. Shell with a denticulated hinge-line. Silur.; N. Am. *S. prisca*, Hall.

LEPTÆNA, Dalman, 1827, emend. Davidson. (Plectambonites, Pander [part], 1830. Leptænulopsis, Haupt.) Valves regularly curved; dorsal concave, thickened, muscular impressions elongated. Fossil, 41 sp. Lower Silurian—Lias; N. Am. and Eur. The Lias Leptænas resemble Thecidia internally; they are free shells, with sometimes a minute foramen at the apex of the triangular deltidium. *S. transversalis*, Dalm. (cxxxviii, 53; cxxxix, 54, 55).

LEPTAGONIA, M'Coy, 1844. (Plectambonites, Pander [part], 1830. Leptæna, King, 1846. Strophomena, Meek, 1873.) Silurian—Carboniferous. *S. rhomboidalis*, Dalm. (cxxxviii, 51, 52).

DAVIDSONIA, Bouchard, 1849.

Etym.—Dedicated to the author of the Monograph of British Fossil Brachiopoda.

Distr.—Fossil, 3 sp. Devonian. *D. Verneuili*, Bouchard (cxxxix, 56, 57). Devonian; Eifel.

Shell solid, attached by outer surface of the ventral valve to rocks, shells, and corals; valves plain, articulated; ventral valve with a wide area; foramen angular, covered by a convex deltidium; disk occupied by two conical elevations, obscurely grooved by a spiral furrow of 5–6 volutions; dorsal valve with two shallow lateral cavities; vascular impressions consisting of two principal submarginal trunks, in each valve, with diverging branches; cardinal and adductor impressions distinct. The furrowed cones undoubtedly indicate the existence of spiral arms, similar to those of Atrypa, but destitute of calcified supports. The upper valve sometimes exhibits markings derived from the surface on which the shell has grown. The mantle-lobes seem to have continued depositing shell until the internal cavity was reduced to the smallest possible limit.

AMPHICLINA, Laube, 1865.

Etym.—*Amphi*, about, and *clino*, a slope.

Distr.—2 sp. Triassic; St. Cassian, Austria. *A. dubia*, Münster.

Shell inequivalve, circular, excavated, smooth; ventral valve convex, beak short; perforated; dorsal concave; hinge-line very short and suboblique; area wanting; deltidium triangular, distinct; structure of the test fibrous, squamose; externally

Amphiclina resembles some Leptænæ, the shell-structure is very similar.

PORAMBONITES, Pander, 1830.

Syn.—Isorhynchus, King, 1849.

Distr.—8 sp. Lower Silurian; Russia and Portugal. *P. æquirostris*, Schloth. (cxxxix, 58).

Shell impunctate; surface minutely pitted; each valve with a minute hinge-area and indications of two septa; foramen angular, usually concealed.

SYNTRIELASMA, Meek and Worthen, 1865.

Distr.—Carboniferous; N. and S. America. *S. hemiplicatus*, Hall (cxxxix, 59, 60).

Shell thin, gibbous or subglobose, in adult specimens; valves articulated by teeth and sockets; hinge-line straight and very short; area small, partly common to both valves, but higher in the ventral valve, where it is divided by a triangular, open foramen; beaks incurved, subequal; surface radiately plicate, and striate, the middle plication of the dorsal valve larger, with corresponding sinus of the other valve; socket-plates of the dorsal valve much as in Orthis, being quite prominent and very diverging, with a linear, longitudinal, mesial ridge between them; dental laminæ of the ventral valve thin, prominent, very closely approximate at their connection with the bottom of the valve, and with a similar mesial septum, extending as three nearly parallel plates to the middle of the valve; muscular and visceral impressions unknown; shell-structure distinctly punctate.

FAMILY PRODUCTIDÆ.

Shell concavo-convex, with a straight hinge-line; valves rarely articulated by teeth; closely appressed, furnished with tubular spines; ventral valve convex; dorsal concave; internal surface dotted with conspicuous, funnel-shaped punctures; dorsal valve with a prominent cardinal process; brachial processes (?) subcentral; vascular markings lateral, broad, and simple; adductor impressions dendritic, separated by a narrow central ridge; ventral valve with a slightly notched hinge-line; adductor scar central, near the umbo; cardinal impressions lateral, striated.

PRODUCTUS, Sowerby, 1814.

Syn.—Protonia, Link, 1830. Arbusculites, Murray, 1831.

Distr.—Fossil, 81 sp. Devonian—Permian; N. and S. Am., Europe, Spitzbergen, Thibet, Australia. *P. giganteus*, Sowb. (cxxxix, 61, 62). *P. horridus*, Sowb. (cxxxix, 63–65).

Shell free, auriculate, beak large and rounded; spines scat-

tered; hinge-area in each valve linear, indistinct; no hinge-teeth; cardinal process lobed, striated; vascular impressions simple, curved; ventral valve deep, with two rounded or subspiral cavities in front. These shells may have been attached by a pedicel when young, the impressions of the pedicel-muscle blending with those of the hinge-muscles in the ventral valve. A few species appear to have been permanently fixed. *P. striatus* is irregular in its growth, elongated and tapering towards the beak, and occurs in numbers packed closely together. *P. proboscideus* seems to have lived habitually in cavities, or half-buried in mud, as suggested by M. d'Orbigny; its ventral valve is prolonged several inches beyond the other, and has its edges rolled together and united, forming a large permanently open tube for the brachial currents. The large spines are most usually situated on the ears of the ventral valve, and may have served to moor the shell; being tubular they were permanently susceptible of growth and repair. Although edentulous, the dorsal valve must have turned on its long hinge-line with as much precision as in those genera which are regularly articulated by teeth.

PRODUCTELLA, Hall, 1867. Like Productus, but hinge-margin with teeth; both valves with area, the larger one with deltidial opening; kidney-shaped impressions very broad. *P. subaculeata*, Murch. Devon.

STROPHALOSIA, King, 1844.

Syn.—Orthothrix, Geinitz, 1848. Leptænalosia, King, 1845.

Distr.—Fossil, 8 sp. Devonian—Carb.; Europe, Himalaya (Gerard). *S. excavata*, Geinitz (cxxxix, 66).

Shell attached by the umbo of the ventral valve; subquadrate; covered with long slender spines; valves articulated, dorsal moderately concave, ventral convex, each with a small area; fissure covered; vascular impressions conjoined, reniform.

AULOSTEGES, Helmersen, 1847. Shell like Productus; ventral valve with a large, flat, triangular hinge-area with a narrow convex pseudo-deltidium in the centre; beak a little distorted, as if attached when young; dorsal valve slightly convex near the umbo; interior as in Productus. *S. Wangenheimii*, Vern. (cxxxix, 67, 68). Permian; Russia.

CHONETES, Fischer, 1837.

Etym.—*Chone*, a cup.

Distr.—Fossil, 47 sp. Silurian—Carboniferous; Europe, North America, Falkland Islands. *C. striatella*, Dalm. (cxxxix, 69–71).

Shell transversely oblong, with a wide and straight hinge-line; area double; valves radiately striated, articulated; hinge-margin of ventral valve with a series of tubular spines; fissure covered; interior punctate-striate; vascular impressions very small.—DAVIDSON.

? AULACORHYNCHUS, Dittmar, 1872.

Distr.—*A. concentrica*, Sem. Carb.; Russia.

Shell thin, broad, concavo-convex, with straight hinge-margin; beak of the large valve strongly curved; no area or deltidium; hinge toothless; muscular impressions small, not well marked; surface leafy, without spines; large valve with a long, two-parted lamella, three-parted at the end, commencing at the beak and only united by the lateral margins with the shell.

[CALCEOLA, Lamarck, 1809.

This is a genus of Cœlenterata.]

ORDER LYOPOMATA.

(Pleuropygia, Bronn. Inarticulata, Huxley.)

Arms free, unsupported by shelly apophyses; intestine opening by a lateral anus (Tretenterata, King); borders of the mantle-lobes entirely disunited; brachia without a distinct median lobe. Shell in most cases without hinge-teeth, articulation or cardinal process.

FAMILY CRANIIDÆ.

Shell orbicular, calcareous, hingeless; attached by the umbo, or whole breadth of the ventral valve, rarely free; dorsal valve limpet-like; interior of each valve with a broad granulated border; disk with four large muscular impressions, and digitated vascular impressions; structure punctate.

Animal with free spiral arms, directed towards the concavity of the dorsal valve, and supported by a nose-like prominence in the middle of the lower valve; mantle extending to the edges of the valves, and closely adhering; its margins plain.

CRANIA, Retzius, 1781.

Etym.—*Kraneia*, capitate.

Syn.—Criopus, Poli, 1791. Orbicula, Cuvier, 1798. Orbicularius, Dumeril, 1806. Choniopora, Schauroth, 1854.

Distr.—5 sp. Spitzbergen, Britain, Mediterranean, India, New South Wales; 150 fathoms. Fossil, 37 sp. Lower Silurian—; Europe.

Shell smooth or radiately striated; umbo of dorsal valve subcentral; of ventral valve subcentral, marginal, or prominent and cap-like, with an obscure triangular area traversed by a central line.

The large muscular impressions of the attached valve are sometimes convex, in other species deeply excavated; those of the upper valve are usually convex.

C. Ignabergensis is equivalve, and either quite free or very slightly attached. *C. anomala*, Müll. (cxxxix, 72–75), is gregarious on rocks and stones in deep water, both in the North Sea and Mediterranean; the animal is orange-colored, and its labial arms are thick, fringed with cirri, and disposed in a few horizontal gyrations.

PSEUDOCRANIA, M'Coy, 1859. (Pholidops, Hall, 1860. Paleocrania, Eichw., 1871.) Is free and has the internal border of the valves smooth; the branchial impressions blend in front. *C. antiquissima*, Eichw.

CRANISCUS, Dall, 1871. (Siphonaria, Quenst., non Sowb.) Fixed valve divided by a transverse and a longitudinal median septum into three cells, the posterior of which contains the muscular impression and the rostrellum. *C. velata*, Quenst. (cxxxix, 76, 77).

ANCISTROCRANIA, Dall, 1877. (Cranopsis, Dall, non Adams, 1871.) Shell attached, upper valve with two slender pointed apophyses divaricating from the internal apex of the upper valve. *C. Parisiensis*, Defrance (cxxxix, 78–80.) Cretaceous.

SPONDYLOBOLUS, M'Coy, 1852. (Spondylobus, Davidson, 1853.) Suborbicular, slightly narrowed towards the short, indistinct hinge-line; nearly equivalve, flattened; hæmal valve with a slightly excentric apex, beneath which, on the interior the substance of the valve is thickened into a wide undefined boss; opposite valve slightly longer, from the apex being perfectly margined and somewhat produced; channeled by a narrow triangular groove, the anterior end of which is flanked within by two very prominent thick conical shelly bosses, representing hinge-teeth; valves thick, testaceous, not glossy, minutely fibrous. *C. craniolaris*, M'Coy. L. Silurian; Ireland.

FAMILY TRIMERELLIDÆ.

Usually massive; umbo of the large valve often large, pointed, solid or hollow, its hinge-face with a well-developed area, and large deltidium, solid throughout; hinge of both valves rudely or faintly dentary; that of the pedicel-valve thick, entire, somewhat elevated, sometimes supported by an upright rib, with a wide median space enclosing a lozenge-shaped scar; that of the brachial valve with a more or less elevated median prominence, or depression; attached to the interior surface of the posterior half of both valves is an elevated platform, solid, or doubly vaulted; from the middle of its anterior end a median plate occasionally projects into the anterior half of the valve, especially the brachial one; both valves have a profound impression or crescent running a little within the margins of their posterior half, including the hinge; a submarginal impression or archlet characterizes the anterior half of the valves.

MONOMERELLA, Billings, 1871.

Distr.—Upper Silurian; Canada, Europe. *M. prisca*, Billings (cxxxix, 81, 82).

Shell thick, circular or transversely oval; large valve with projecting umbo, double-chambered; area and deltidium large; hinge generally thick and elevated, ledge-shaped, depressed in the middle; cardinal facet a wall-like space rising out of or behind the ledge of the hinge; cardinal buttress strong, lamelliform; platform flat; slightly elevated; widest, highest and very obtusely angulated in front; in the brachial valve the platform is trilobed, usually with a thin margin.

DINOBOLUS, Hall, 1871.

Syn.—Rhynobolus, Hall (part), 1871. Obolellina, Billings (part), 1871. Conradia, Hall, 1874.

Distr.—Upper Silurian; N. Am., Europe. *D. Davidsoni*, Salter. *D. Conradi*, Hall (cxl, 83, 84).

Shell circular, or transversely oval, moderately thick; pedicel-valve with slightly prominent umbo; area wider than long; platform more or less sinuated; widely V-shaped and slightly raised in front; crescent prominently marked in its crown and sides; hinge moderately thick, with a rounded edge on which, and in front of the cardinal facet, is a pair of scars; brachial valve rather tumid at the umbo, somewhat strongly trilobed, outer margins a little raised, antemedian portion rounded, projecting, and terminating in a slightly developed median plate; crescent a strongly marked linear scar on the hinge, arching forward in front of the cardinal facet, inner border of its sides with strongly marked indentations, outer border a fine line; a rather strongly marked subcardinal scar in the umbonal cavity; a large rhomboidal postmedian scar in front of the latter.

TRIMERELLA, Billings, 1862.

Syn.—Rhynobolus, Hall (part), 1871. Obolellina, Billings (part), 1871. ? Gotlandia, Dall, 1871.

Distr.—7 sp. Silurian; Canada, U. S. *T. Lindstromi*, Dalm. (cxl, 85-87).

Valves thick, longitudinally oval; umbo of pedicel-valve usually massive, solid, occasionally double-chambered, irregularly projecting; area of considerable size, longer than wide; deltidium large; hinge generally thick and elevated, rudely or slightly dentary, and variously modified in different species; cardinal facet large; crescent rather well-defined in typical species; platforms elevated, and doubly vaulted, occasionally solid and slightly raised; median plate occurring generally in both valves, largest in the brachial one.

? CHELODES, Davidson, King, 1874.

Distr.— U. Silurian; Gotland, Sweden. *C. Bergmani*, D. and King.

Notwithstanding remarkable points of resemblance, it is our opinion that it is not a palliobranch; on the contrary, we are strongly inclined to the belief that it belongs to a section of the cœlenterates, represented by Calceola and Gonicphyllum.—DAVIDSON AND KING.

Possibly a coral. Looks like the internal fulcrum of Zirphæa (Leuconyx, H. Adams).—DALL.

LINGULOPS, Hall, 1871.

Distr.—L. Silur.; N. Am. *L. Whitfieldi*, Hall.

Founded upon a cast of the interior of a single valve of a Lingula-shaped shell, but differing from that genus in its interior impressions. The most striking features are: first, a posterior, semicircular, broad zone, with an inner sinused border; second, an arched fillet situated below the hinge and on the zone, the crescent characterizing the Trimerellids; third, a central space marked with scars (the apophysary system); fourth, linear impressions occurring in the anterior half of the fossil median plate, and pair of primary vessels belonging to the brachiocœle.

FAMILY DISCINIDÆ.

Shell attached by a pedicel, passing through a foramen in the ventral valve; valves not articulated; minutely punctate.

Animal with a highly vascular mantle, fringed with long, horny setæ; oral arms curved backwards, returning upon themselves, and ending in small spires directed downwards, towards the ventral valve.

DISCINA, Lamarck, 1819.

Syn. — Orbicula, Sby. (not Cuvier), 1830. Schizotreta, Kutorga, 1848.

Distr.—10 sp. West Africa, W. Indies, Malacca, Peru and Panama. Fossil, 64 sp. Silurian—; Europe, United States, Falkland Islands. *D. striata*, Schum.

Shell orbicular, horny; upper valve limpet-like, smooth or concentrically lamellose, apex behind the centre; lower valve flat or conical, with a sunk and perforated disk on the posterior side, from which interiorly extends a furrow; interior polished

Animal transparent; mantle-lobes distinct all round; labial folds united, not extensile; alimentary canal simple, bent upon itself ventrally, and terminating between the mantle-lobes on the right side. There are four distinct adductor muscles, as in Crania; and three pair of adjuster muscles for keeping the

valves opposed to each other. Some of these are probably inserted in the pedicel. The oral cirri are extremely tender and flexible, contrasting with the stiff and brittle setæ of the mantle, which are themselves setose like the bristles of certain annelides (*e. g.*, the sea-mouse, Aphrodite). The relation of the animal to the perforate and imperforate valves is shown to be the same as in Terebratula by the labial fringe; but the only process which can possibly have afforded support to the oral arms is developed from the centre of the ventral valve, as in Crania. Baron Ryckholt has represented a Devonian fossil from Belgium, with a fringed border; but if this shell is the *Crania obsoleta*, of Goldfuss, the fringe must belong to the shell, and not to the mantle.

In some species the valves are equally convex, and the foramen occupies the end of a narrow groove.

ORBICULOIDEA, d'Orb., 1847. (Schizotreta, Kutorga, 1848.) Perforation at the posterior, instead of the anterior, end of the internal furrow, which last is impressed from the outside, instead of from the inside, as in Discina. *D. elliptica*, Kutorga.

DISCINISCA, Dall, 1871. Lower valve more or less flattened, concave or compressed, upper valve more convex; apices of both subcentral or subposterior; lower valve with a small septum, as in Discina, behind which is a disk or area impressed from the outside, and traversed by a longitudinal fissure in the median line of the valve; shell more or less horny in texture, minutely tubulous. Silurian—Recent. *D. lamellosa*, Brod. (cxl, 88–93).

PATERULA, Barrande.

Syn.—Cyclus, Barr.
Distr.—*P. Bohemica*, Barr. Silur.; Bohemia.

FAMILY OBOLIDÆ.

Shell somewhat inequivalve, rounded or oblique, calcareo-corneous; hinge-margin thickened, and grooved for the passage of the peduncle; posterior adductor scars more or less distant from the median line.

OBOLUS, Eichwald, 1829.

Etym.—*Obolus*, a small Greek coin.
Syn.—Ungulites, Ungula, Pander, 1830. Aulonotreta, Kutorga, 1848.
Distr.—Fossil, 8 sp. Lower and Upper Silurian; Sweden, Russia, England, United States. *O. Davidsoni*, Salter (cxl, 94, 95).

Shell orbicular, calcareo-corneous, depressed, subequivalve, smooth; hinge-margin thickened inside, and slightly grooved

in the ventral valve; posterior adductor impressions separate; anterior pair subcentral; impressions of adjusters lateral.

OBOLELLA, Billings, 1861.

Eym.—Diminutive of *Obolus.*

Syn.—? Keyserlingia, Pander, 1861.

Distr.—12 sp. Cambrian, Lower Silurian; United States, Canada, England, Spain. *O. chromatica*, Billings (cxl, 99, 100).

"Shell ovate, circular or subquadrate, convex or plano-convex; ventral valve with a false area, which is sometimes minute, and usually grooved for the passage of the peduncle; dorsal valve either with or without an area; muscular scars in the ventral valve four; one pair in front of the beak near the middle, or in the upper half of the shell, and others situated one on each side near the cardinal edge; shell calcareous; surface concentrically striated, sometimes with thin, extended, lamellose edges.

"In general form these small shells somewhat resemble Obolus, but the arrangement of the muscular impressions is different. In Obolus the two central scars have their smaller extremities directed downwards, converging towards each other; but in this genus the arrangement is exactly the reverse."—BILLINGS.

KUTORGINA, Billings, 1861. Hinge-line straight, nearly as wide as the shell, sides nearly straight, meeting the cardinal border at an obtuse angle; neural valve with an area and foramen; a pair of subcentral, oval muscular impressions, but no vestiges of lateral scars; externally radiately striate. Cambrian; Canada. *O. cingulata*, Billings (cxl, 1, 2).

MONOBOLINA, Salter, 1865. Shell resembling Obolus; broad, external surface radiately striated; muscular scars united closely along the central line. Silur.; England. *O. plumbea*, Salter.

SCHMIDTIA, Volborth, 1869.

Syn.—Dicellomus, Hall? 1871.

Distr.—Silur., Devon.; Russia, N. America.

Shell very small, long-oval, shining; large valve swollen, with pointed beak, and grooved area; within two deep muscular impressions; in the small valve a raised ledge between the impressions.

LEPTOBOLUS, Hall, 1871.

Distr.—3 sp. Silurian; N. America. *L. lepis*, Hall (cxl, 3, 4).

Shell small, thin, swollen, oval; large valve with a short beak, and deeply, broadly grooved area; within a two-parted, somewhat raised muscle-plate; small valve slightly thickened dorsally, with an internal, three-parted, diverging, muscular impression.

? ACRITIS, Volborth, 1869.

Distr.—Silur.; Russia. *A. sculpta*, Kutorga.

ACROTHELE, Linnarson, 1876.

Distr.—Cambrian; Eur., N. America. *A. coriacea*, Linnarson.

Shell horny, consisting of layers, of which the outer one is rough, the inner one smooth and shining; ventral shell depressed-conical, with perforated apex; from the apex to the hinder margin the surface is flattened; small valve with a curved marginal apex arising from two wart-like projections; within having two long, diverging muscular impressions in front of the hinge-margin, and two small, round ones in the middle, with a median ridge between them.

? IPHIDEA, Billings, 1874.

Distr.—3 sp. Cambrian; Canada, Newfoundland, Sweden. *I. bella*, Billings.

Resembles Acrotreta, but differs in having a large, convex deltidium.

TREMATIS, Sharpe, 1847.

Syn.—Orbicella, d'Orbigny, 1847.

Distr.—Fossil, 14 sp. Lower and Upper Silurian; North America and Europe. *T. terminalis*, Emmons (cxl, 96–98).

Valves convex, superficially punctate; dorsal valve with a thickened hinge-margin (and three diverging plates, indicated on casts.—SHARPE).

SCHIZOCRANIA, Hall and Whitfield, 1875.

Distr.—L. Silurian; Ohio. *S. filosa*, Hall (cxl, 5).

Shell inequivalve, rounded; lower valve attached, posteriorly with a deep, triangular sinus, reaching almost to the middle of the valve; upper valve convex with posterior beak and six internal muscular impressions.

SIPHONOTRETA, Verneuil, 1842.

Etym.—*Siphon*, a tube; *tretos*, perforated.

Syn.—? Mesotreta, Kutorga, 1848.

Distr.—Fossil, 9 sp. Lower and Upper Silurian; Britain, Bohemia, Russia. *S. verrucosa*, Vern. (cxl, 6–8).

Shell oval, biconvex, slightly beaked, conspicuously punctate, or spiny; beak perforated by a tubular foramen; hinge-margins thickened; ventral valve with four close adductor scars surrounding the foramen. The spines are tubular, and open into the interior of the shell by prominent orifices.—CARPENTER. *S. anglica*, Morris, has moniliform spines.

ACROTRETA, Kutorga, 1848.

Distr.—3 sp. Cambrian, Lower Silurian; Russia, England, Sweden. *A. subconica*, Kutorga (cxl, 9, 10).

Shell triangular; large valve bullet-shaped, with a high area and toothless hinge-margin; end of the beak with round perforation; surface not spiny.

? VOLBORTHIA, Möller, 1874.

Distr.—*V. recurva*, Kutorga. Silurian; Russia.

HELMERSENIA, Pander, 1861.

Distr.—Lower Silurian; Russia.

Shell nearly equivalve, rounded, small, horny-cretaceous; lower valve with slightly produced beak, perforated, area narrow, grooved; upper valve with thickened hinge-margin; muscular impressions as in Obolus.

FAMILY LINGULIDÆ.

Shell oblong or orbicular, subequivalve, attached by a pedicel passing out between the valves; texture horny, minutely tubular.

Animal with a highly vascular mantle, fringed with horny setæ; oral arms thick, fleshy, spiral, the spires directed inwards, towards each other.

LINGULA, Bruguière, 1789.

Etym.—*Lingula*, a little tongue.

Syn.—Pharetra, Bolten, 1798. Glossina, Phill, 1848.

Distr.—16 sp. India, Philippines, Moluccas, Australia, Feejees, Sandwich Islands, West America, North Carolina. Fossil, 140 sp. Lower Silurian—; North America, Europe, Thibet. *L. anatina*, Lam. (cxl, 11–13). *L. Murphiana*, King (cxl, 14).

Shell oblong, compressed, horny, greenish, slightly gaping at each end, truncated in front, rather pointed at the umbones; dorsal valve rather shorter, with a thickened hinge-margin, and a raised central ridge inside.

Animal with the mantle-lobes firmly adhering to the shell, and united to the epidermis, their margins distinct, and fringed all round; branchial veins giving off numerous free, elongated, narrow loops from their inner surfaces; visceral cavity occupying the posterior half of the shell, and surrounded by a strong muscular sheath; pedicel elongated, thick; stomach long and straight, sustained by inflections of the visceral sheath; intestine convoluted dorsally, terminating between the mantle-lobes on the right side, oral arms disposed in about six close whorls, their cavities opening into the prolongation of the visceral sheath in front of the adductors.

ENDIX.

ND CORRECTIONS.

of the Mollusca.

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he Virgin Islands and St. Barts are to be added to the fifth group: but south of a line drawn to the north of Saba and Barbuda, the fauna changes remarkably. South of that line Macroceramus and Strophia disappear; Cylindrella is represented by two or three species only. Important operculate genera also are absent, Tudora, Cistula, etc.

Group 7. Barbados is peculiar; the Cyclostomæ not represented; Streptaxis found there (as well as in Trinidad), and also Bulimus (Borus) oblongus.

Group 8. Windward Islands, Curaçao and Buen Ayre. The islands from and including Guadeloupe to Grenada are called the Windward Islands; Trinidad and Tobago should go together as a separate group; and again, as another group, Aruba, Curaçao and Buen Ayre.

The grouping somewhat corresponds with the depth of the surrounding water; with some curious exceptions: between St. Thomas and St. Croix the depth is 1570 fathoms; nearly 1000 fathoms between Martinique and St. Lucia; between St. Vincent and Barbados, 1493 fathoms.

Bahamas and Turk's Is. [p. 201]. The number of species

Lingulæ existed in the British seas as late as the period of the Coralline Crag. The recent species have been found at small depths, and even at low-water half buried in sand. *L. Davisii*, Lower Silurian, Tremadoc, has a pedicel-groove like Obolus.

GLOTTIDIA, Dall, 1870. Shell with two diverging internal laminæ in the neural valve proceeding from the beak, and a mesial septum in the hæmal valve; otherwise like Lingula. 6 recent sp. E. and W. coasts of North America. *L. albida*, Dall. California.

LINGULELLA, Salter, 1866. (*Etym.*—Diminutive of *Lingula.*) "Shell nearly equivalve, broad, oblong, the ventral valve pointed, with a distinct pedicel-groove. Muscular scars strong, nearly as in Obolus, but the pair of anterior retractors are more linear than in Obolus, and the sliding muscles small, and not quite external as in Obolus."—SALTER. 3 sp. Cambrian, Lower Silurian; Ireland, Wales, Norway. *L. Davisii*, M'Coy.

LINGULEPIS, Hall, 1863. (*Etym.*—*Lingula*, a little tongue; *lepis*, a scale.) Shell thin, subovate, or subtrigonal; composition and structure as in Lingula. Ventral or larger valve with beak more or less produced and pointed; visceral scar trilobed, with a longitudinal raised mesial line or septum—lateral divisions diverging, and usually longer than the middle one; dorsal or smaller valve with the beak less produced than that of the other; visceral scar flabelliform. 4 sp. Cambrian; America. *L. pinniformis*, Owen.

DIGNOMIA, Hall, 1873. With strong internal median septum, otherwise as in Lingula. Silurian—Devonian; U. S. *L. alveata*, Hall.

APPENDIX.

Additions and Corrections.

Vol. I.

Geographical Distribution of the Mollusca.

Mr. Thomas Bland, of New York, who is so well acquainted with the distribution of the land shells of the West Indies, has kindly sent me the following notes and corrections:

[P. 180.] *Helix similaris*, Fer, has been found in Barbados only, of the West India Islands; an accidental introduction, no doubt, as coffee is not cultivated there. It is not found in Jamaica, Hayti or Porto Rico, in all of which coffee is cultivated.

[P. 198.] *Peruvian Region.* The occurrence of Cyane (Proserpinacea) is remarkable.

[P. 201.] *Caribbæan Region.* In the faunal grouping of the islands Turk's Islands should go with the (1) Bahamas; and with (4) Hayti and Navassa, the important island of Gonave, in which there are 21 species—9 peculiar.

The Virgin Islands and St. Barts are to be added to the fifth group; but south of a line drawn to the north of Saba and Barbuda, the fauna changes remarkably. South of that line Macroceramus and Strophia disappear; Cylindrella is represented by two or three species only. Important operculate genera also are absent, Tudora, Cistula, etc.

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The grouping somewhat corresponds with the depth of the surrounding water; with some curious exceptions: between St. Thomas and St. Croix the depth is 1570 fathoms; nearly 1000 fathoms between Martinique and St. Lucia; between St. Vincent and Barbados, 1493 fathoms.

Bahamas and Turk's Is. [p. 201]. The number of species

now known is 77; about 40 peculiar. Three of the operculates are found also in Cuba.

Jamaica, Stoastoma, has two extra-limited species, one in Hayti, and one in Porto Rico.

Hayti. Gonave has 21 species, of which 8 are operculates. There are two peculiar species of Cylindrella, and curiously, a form of *Helix sagemon*, of Cuba.

The gradual diminution of genera easterly is curious: Megalomastoma disappears; there is a fossil *impression* of Strophia in Sombrero, and a fossil species in St. Croix. Strophia, Macroceramus, Megalomastoma, Tudora, Cistula, are absent in the Lesser Antilles; there is one Macroceramus on the Anguilla Bank. Cyclophorus is represented in the West Indies only in the Lesser Antilles.

Table of Sedimentary Deposits [p. 224].

Strike out from Pliocene the Sumter Period, and insert in Miocene (Eastern U. S.):

Carolinian (Sumter), so as to stand opposite Sarmatian [p. 225].

[P. 225.] Instead of Yorktown Period, put

$\left\{\begin{array}{l}\text{Virginian,}\\ \text{(Yorktown,)}\\ \text{Marylandian,}\end{array}\right.$ so as to stand opposite Mediterranean Stages, etc.

[P. 226.] (R. h. column, at bottom), instead of "Panfield," read "Punfield."

[P. 227.] Jurassic (r. h. column), after "Great Oolite" insert "Dogger."

[P. 229.] (R. h. column, at top), instead of "Ludovian," read "Ludlovian."

Classification [p. 252].

Macdonald (Jour. Linn. Soc., xv, 161, 255) discusses the value of some of the characters employed in the classification of the Mollusca, pointing out the existence of several analogous genera, and analogous subdivisions of the Heteropoda and Pulmonata. He proposes the following system for the gastropods:—

Division I. Monœcia.

Subdivision I. Lingual dentition typically pavimental.

Order 1. Pneumonophora.

Suborder 1. Pulmonata.

A. Terrestrial; B. Aquatic; C. Estuary or Marine.

Order 2. Apneumonophora.

Suborder 1. Nudibranchiata.

A. Cryptobranchiata (Phylliroë, Elysia, Limapontia, etc.).

B. Phanerobranchiata (Eolis, Doris, Tritonia, Phyllidia, etc.).

Suborder 2. Tectibranchiata (Pleurobranchus, Aplysia, Bulla, Tornatella, etc.).

Subdivision II. Lingual membrane strap- or ribbon-like, rhachis and pleura distinctly differentiated, dental processes recurved (Anclodonta).

Order 1. Heteroglossa (Gray).

Suborder 1. Polyplacophora (Chiton, Chitonellus).

Suborder 2. Cyclobranchia (Patella, Patina).

Suborder 3. Cervicobranchia (Tectura, Gadinia, Lepeta).

Suborder 4. Cirrobranchia (Dentalium).

Order 2. Rhachidoglossa (Gray).

Suborder 5. Dicranobranchia. Gills two, symmetrical on the back of the neck (Scutus, Doridobranchus, Emarginula, Puncturella, Fissurella).

Suborder 6. Schismatobranchia. Gills in two plumes on the left side of the gill cavity (Teinotis, Padollus, Haliotis, Scissurella).

Suborder 7. Scutibranchia. Gills in a spiral line on the left side (Stomatella, Trochus, Turbo, Rotella, Nerita, Neritina, Navicella).

Suborder 8. Pseudobranchia. No distinct gills (Helicina, Proserpina, Ceres). [Nearly all of the groups of subdivision II of "Monœcia," are known to be diœcious.—G. W. T., Jr.]

Division II. Diœcia.

Subdivision I. Lingual membrane unarmed, or with pleural teeth only.

Order 1 (without name).

A. Rhachis and pleuræ unarmed (Pyramidellidæ, Cancellariidæ). [Cancellaria has an armed radula.]

B. Pleural teeth simple [Toxoglossa, Troschel] (Pleurotomidæ, Acusidæ, Conidæ).

C. Dentition, Pavimental [Ptenoglossa, Troschel] (Solariidæ, Scalariidæ, Ianthinidæ).

Subdivision II. Lingual membrane strap- or ribbon-like.

Order 1. Proboscidifera.

Suborder 1. Orthodonta. Dental processes pointing directly backwards [Rhachiglossa, Troschel].

A. Lingual dentition uniserial (Volutidæ [See suborder II]).

B. Lingual dentition triserial.

a. Rhachis and pleuræ comb-like.

Dental processes numerous, small.

Strap short (Mitridæ). Strap long. Teeth short (Fasciolariidæ). Teeth long (Fusidæ).

Dental processes few and large (Turbinellidæ).

b. Pleuræ uncinatæ.

Uncinus with an additional internal cusp (Buccinidæ).

Uncinus simple, rhachis armed.

Cusps, large, few (Muricidæ, Olividæ, Harpidæ).

Cusps small, numerous (Turritidæ).

Uncinus foliated, rhachis unarmed (Columbellidæ).

Suborder 2. Anactodonta [Tænioglossa, Troschel]. Cusps recurved from the fore-part of the plates (Volutidæ, Naticidæ, Tritonidæ, Ranellidæ, Doliidæ, Cassididæ, Strombidæ).

Order 2. Rostrifera.

Suborder 1. Orthodonta (Heteropoda and Phoridæ).

Suborder 2. Anaclodonta [Tænioglossa, Troschel].

A. Marine or littoral (Cypræidæ, Vermetidæ, Calyptræidæ, Planaxidæ, Littorinidæ, Cerithiidæ, Rissoidæ, Truncatellidæ).

B. Aquatic (Melaniidæ, Paludinidæ, Valvatidæ).

C. Terrestrial (Cyclophoridæ, Cyclostomidæ, Diplommatinidæ).

Herman v. Jhering's classification of the mollusca, published in the "Jahrbücher der Deutschen Malakozoologischen Gesellschaft," iii, 1876, and "Vergleichende Anatomie des Nervensystemes und Phylogenie der Mollusken," 1877, has not met with general acceptance; the only novelty in most of his groups being the new names. In the few real changes made he is singularly unhappy, the characters being in disaccord with others generally recognized as of much greater importance. Dr. Paul Fischer thus concludes a careful review of von Jhering's works: "He has endeavored to introduce into the classification certain characters afforded by the nervous system. He is premature in this, for what we know of the nervous system is absolutely insufficient. For the rest, his classification is only a combination of characters derived from the branchiæ and dentition. It is worth neither more nor less than those of Mörch, Gray, Gill, Adams, etc., and I do not find in it a trace of real progress; only the names of the fundamental divisions have been changed. Is this the last word of the new anatomical school?"—Fischer, "Sur la nouvelle classification des Mollusques de M. von Jhering," Journal de Zoologie, vi, Paris, 1877.

The late Dr. Troschel (Archiv für Naturgeschichte, 1876) speaks quite as plainly as to the demerits of this classification, and takes the opportunity to disclaim any intention, by his own studies of the dentition of the mollusca, to advocate the exclusive use of the characters afforded by the lingual organ in classification. This veteran conchological anatomist modestly

refers to his life-work as "a contribution towards the knowledge of a single character among the many that must be taken into account in making a natural classification."

Several other recent attempts to classify the mollusca upon single or partial characters are equally or more incongruous; and were therefore omitted from my chapter on classification.

On Collecting and Arranging Shells [p. 290].

The new liquid glues sold by stationers, such as "Royal," "Chase's," "Lepage's," etc., are highly recommended for attaching specimens to the cardboard labels. They have a great advantage in being always ready for use, but do not possess sufficient *body* to fix heavy specimens in every position desired; this deficiency may be supplied by the use of yellow wax, which may be moulded to any shape required, and then attached with the glue both to the cardboard and specimen.

[Vol. II.]

CEPHALOPODA.

[P. 46.] 5th line from bottom, instead of "liassic," read "jurassic."

Acanthoteuthis, Wagner [p. 48].

phragmoteuthis, Mojsisovics, 1882. Triassic; Europe. *A. bisinuatus*, Bronn.

Orthoceras, Breyn [p. 51].

5th line from bottom, instead of "L. Silurian," read "Cambrian."

endoceras, Hall; cameroceras and diploceras, Conrad.

The two groups, Endoceras and Cameroceras, appear to be very closely allied, if not identical forms; the latter being founded upon a species (*C. Trentonensis*) possessing an inner sheath or tube which is permanently attached to the septa in precisely the same manner as that of Endoceras, and differing simply in its lateral position, beaded form, and more gradual expansion; the tube of Endoceras, moreover, is not always central. Its expansion is more rapid, when it occurs; there are also occasionally additional and apparently free tubes within the first or permanent tube of Endoceras, which do not occur in Cameroceras.

Diploceras appears to have possessed an inner tube of large size, surrounded by septa and an outer tube, the inner tube being near one side of the outer one; it also is probably identical with Endoceras.—Whitfield, *Geol. Wisconsin*, iv, 228.

rhynchorthoceras, Remelé, 1881. (Ancistroceras, Boll [part], 1857.) *O. Breynii*, Boll. L. Silur.; Germany.

LITUITES, Breyn [p. 56].

Add to synonymy Ancistroceras, Boll (part), 1857.

NAUTILUS, Breyn [p. 60].

SOLENOCHILUS, Meek and Worthen, 1870. Proposed instead of Cryptoceras, d'Orb, 1850, not of Barrande, 1846 (changed to Ascoceras), nor Cryptoceras, Latreille (Hymenoptera), 1804. A carboniferous species, *Nautilus* (*Solenochilus*) *collectus*, M. and W., is described from Indiana.

PLEURONAUTILUS, Mojsisovics, 1882. Triassic; Europe.

AMMONITES, Brug. [p. 60].

Mojsisovics has characterized the following new Ammonite genera in "Cephalopoden der Mediterranean Triasprovins," 1882:—

DINARITES, KLIPSTEINIA (*Ceratitæ*).

CELTITES (*Tropitæ*).

PROCLADISCITES (*Arcestæ*).

BENECKEIA, LONGOBARDITES, LECANITES, NANNITES, GYMNITES, STURIA (*Pinacoceræ*).

PETALICHNUS, TERATICHNUS, TRACHOMATICHNUS, S. A. Miller, Jour. Cin. Soc. ii, 1880.

SÆRICHNITES, Billings, Cat. Sil. Foss. Antic, 1866.

Are names given to supposed tracks of cephalopods.

GASTROPODA.

PROSOBRANCHIATA [p. 103].

Carelessness and habit have caused the retention of the old order Scutibranchiata, notwithstanding the loss of its principal distinctive characters. The position and development of the branchiæ vary, usually according to the form of the shell, and these no longer afford satisfactory characters; although in the Scutibranchiata the branchiæ are more usually a pair, whilst in the Pectinibranchiata one leaf is more or less abortive. The scutibranchiates were formerly supposed to be androgynous, but the sexes are now known to be separated, although the want of a penis in the male prevents them from being externally distinguishable. The shells of the first suborder of scutibranchiates, the Podopthalmæ, are not separable from the holostomate pectinibranchs, such as Natica, although in general the pectinibranchs are siphonostomate, the scutibranchs holostomate; in the second suborder, Edriopthalma, the conical, non-spiral shells form a good conchological character.

For the first suborder (with the addition of the Fissurellidæ

from the second) Prof. Gill uses the name Rhipidoglossa, characterized by the development of numerous hooklets or uncini upon either side of the central and few lateral teeth of the lingual ribbon (vol. i, Pl. xii, f. 43–50). But this character is not coextensive with the order Scutibranchiata, although nearly so, and is besides of doubtful importance. Rather than use it in combination with a modification of the extent and characters of the Scutibranchiata, I prefer to suppress that order entirely, as Fischer has done, and as I originally intended to do (vol. i, p. 82).

In the case of Helicina, which possesses the dentition and form of shell of the scutibranchs, there is an external sexual organ in the male, thus allying it with typical pectinibranchs. This and the other land mollusks provided with opercula, and in which the branchiæ are represented by a network spread upon the walls of a pulmonary chamber, are by some systematists made a separate order, Pneumonopoma, connecting the pectinibranchs with the Pulmonata; they are closely connected through Ampullaria, etc., as well as by their opercula and bisexuality, with the former.

The second suborder of scutibranchs, the Edriopthalmæ, are distinguished from ordinary pectinibranchs by their conical shell, but vary greatly among themselves in dentition (the Patellidæ, etc., being docoglossate (vol. i, Pl. xii, f. 51), and in the form and position of the branchiæ (vol. ii, 326, 329, 330, 331, 332).

The limits of the order Pectinibranchiata should be enlarged to include the non-spiral shells and variously situated gills of the limpets, and the aberrant, pneumonopomous, operculated terrestrial mollusks.

I annex Fischer's classification:

Class Gastropoda.
Subclass Univalvia.
Androgyna.
Order 1. Pulmonata.
Order 2. Opisthobranchiata.
Dioica.
Order 3. Nucleobranchiata (Heteropoda).
Order 4. Prosobranchiata (Platypoda).
Subclass Multivalvia.
Order 5. Polyplacophora.

COLUMBELLA, Lam. [p. 178].

MITROLUMNA, Bucq., Dautz. et Dollf., 1883. Proposed for a group of shells uniting the characters of Mitra and Columbella: no operculum. Type, *Columbella Greci*, Phil. Mediterranean.

PLEUROTOMA, Lam. [p. 183].

TERES, Bucq., Dautz. et Dollf., 1883. Shell small, columella straight and thin, lip thin, spire and aperture both long. *Pl. anceps*, Eichw. Intended to include a number of small forms heretofore classed with Drillia.

BELLARDIA, Bucq., Dautz. et Dollf., 1883. Shell small, lanceolate, with sutural sinus, lip and columella thin; oblique ribbed and coronate. *P. gracile*, Mont. Europe.

(*Mangilia.*)

MANGILIELLA, Bucq., Dautz. et Dollf., 1883. Shell more lanceolate than Mangilia, more fusiform, with oblique ribs. Intermediate between Mangilia and Raphitoma. *M. multilineata*, Desh. Mediterranean.

(*Bela.*)

HÆDROPLEURA, Monterosato, 1883. Shell operculate, not turriculated, strongly ribbed. *B. septangulare*, Mont. Mediterranean. (Bela is restricted to the boreal turriculated species, of light texture.)

DONOVANIA, Bucq., Dautz. et Dollf., 1883. Instead of Lachesis, Risso, 1826, preoccupied by Daudin, 1804 (Reptiles), and Savigny (Arachnids). Nesæa, Risso, which is synonymous with Lachesis, is also preoccupied by Lamarck (Polypes) and Leach (Crustaceans).

CASSIS, Lam. [p. 200].

Brugnonia pulchella, Jeffreys, is perhaps the fry of *Cassis sulcosa.*—Ann. Mag. N. Hist., xii, 67, 1883.

NATICA, Lam. [p. 204].

PAYRAUDEAUTIA, Bucq., Dautz. et Dollf., 1883. Characterized by three umbilical grooves, the subcentral one large, separated by two plications. Operculum corneous. *N. intricata*, Donovan. Mediterranean.

SCÆVOGYRA, Whitfield, 1877.

Distr.—3 sp. Fossil. L. Magn. Limestone; Wisconsin. *S. Swezyei*, Whitfield.

Shell thin, sinistral, spire more or less elevated, of rounded volutions; umbilicus broad, open; peristome entire, uniting with the preceding volution on the inner side, and more or less spreading or trumpet-shaped externally. Appears to be related to the family Naticidæ.

LYOSOMA, White, 1883.

Distr.—2 sp. Jurassic; Utah. *L. phaseolaris*, White.

Shell resembling certain forms of Neritina and Nerita in

general aspect; volutions few, the last one much expanded; outer lip moderately thin; inner lip moderately thickened and apparently without any callus; the portion of the body, exclusive of the last volution, very small and without a proper columella. Family relations doubtful, but they are probably with the Velutinidæ. [See p. 294, vol. ii.]

TURRITELLA, Lam. [p. 224].

SMITHIA, Maltzan, 1883. Like Eglisia, but the whorls not in contact, with revolving striæ; peristome simple. Operculum corneous, multispiral. *S. gracilis*, Maltzan. Isl. Gorée.

Littorinidæ [p. 240].

IPHITUS, Jeffreys, 1883.

Etym.—One of the Argonauts.

Type.—*I. tuberatus*, Jeffreys. Europe.

Shell conical, covered with spiral rows of tubercles; the apex consists of a cylindrical process of several whorls, which is closely striated lengthwise; operculum horny, paucispiral with a lateral nucleus.

The peculiar apex may be compared to the styliform process of Ianthina and Stylifer, and there are several other genera, such as Cæcum and Turritella, in which the embryonic spire, which had become useless for the occupancy of the mollusk, is decollated or plugged up.

RISSOA, Frem. [p. 264].

HEMISTOMIA, Crosse. Mr. E. Marie, who collected this mollusk in New Caledonia, writes to me that it is fluviatile; it should therefore be removed to the subfamily Hydrobiinæ.

DIPLOMMATINA, Benson [p. 282].

One species occurs in the island of Trinidad, West Indies.

Helicinidæ [p. 290].

The dentition (which is really rhipidoglossate) is erroneously described from H. and A. Adams' "Genera." The figure referred to, however, correctly represents it. The family has been usually included under the old order Scutibranchiata.

ORDER SCUTIBRANCHIATA [p. 293].

This order (and its suborders) may be suppressed. See p. 348.

VELATES, Montf. [p. 298].

VELATELLA (Meek, 1872), White, 1883. Shell resembling both Dostia and Velates, suboval, flattened beneath, depressed-convex

above, with a minute submarginal apex; inner lip large, flattened or slightly convex, the margin smooth or crenulate; outer lip usually a little thickened and sometimes crenulate within, and more or less continuous with the inner lip; aperture comparatively small; surface smooth or radiately ribbed; usually polished. Differs from Dostia in its more nearly perfect bilateral symmetry and minute apex; from Velates in its marginal apex. 4 sp. Cretaceous and Laramie; U. S.

CYCLOSTREMA, Marryat [p. 299].

THARSIS, Jeffreys, 1883. (*Etym.*—One of the many synonyms of Cyprus.) Shell globular, solid and glossy; peristome circular and continuous, but attached to the pillar on that side; base closed by a pad or thick testaceous layer in the adult, perforated in the young; operculum chitinous or horny, and multispiral. This genus differs from Cyclostrema in the peristome being, although continuous, not free or detached from the rest of the shell, and in the umbilicus being closed instead of open in the adult. Type, *T. Romettensis*, Seguenza. Mediterranean.

GANESA, Jeffreys, 1883. (*Etym.*—The Hindoo god of science.) Shell shaped like a Natica, thin; peristome continuous, free and separate in the young, but united to the periphery in the adult; spire having an oblique axis; base perforated, not umbilicate; operculum horny, multispiral. Differs from Tharsis in the obliquity of the spire and the perforation of the base at every stage of growth. 2 sp. Europe. *G. pruinosa*, Jeffreys.

Fissurellidæ [p. 326].

? DIRINUS, M'Coy, 1844.

Distr.—*D. Bucklandi*, M'Coy. Carboniferous; Ireland.

Patelliform; apex perforated by two oval foramina, symmetrically placed one on the right side, the other on the left.

A very problematical fossil.

CYLICHNA, Lovén [p. 359].

CRYPTAXIS, Jeffreys, 1883. Shell small, white, glossy, sometimes with fine revolving striæ; spire deeply sunken, and for the most part concealed in a small cavity in the centre of the crown, but showing the apex and sometimes one or two whorls at the bottom of the cavity. 4 sp. Deep-sea; Europe. *C. crebripunctatus*, Jeffreys. Intermediate between Cylichna and Utriculus.

RHODOPE, Kölliker [p. 391].

This is not a mollusk, but a peculiarly aberrant Turbellarian. —*Science*, i, 433.

Vol. III.

PELECYPODA.

Cyprinidæ [p. 187].

Roudairia, Munier-Chalmas.

Syn.—Trigonocardia, Zittel.

Distr.—Cretaceous; N. Africa, India. *R. Drui*, Mun.-Chal. (cxv, 49–51).

Shell trigonal or trapezoidal, thick, convex; beaks prominent, incurved, anterior, with a deep lunule under them; posteriorly a sharp keel, behind which the surface is smooth, the rest of the shell being folded; hinge-margin thick; the right valve with three cardinal teeth, the posterior one separated from the central by a deep pit, and divided, the anterior tooth horizontal, there is a strong posterior lateral tooth; in the left valve the posterior cardinal is small, the middle one very large, the anterior divided, its branches diverging, posterior lateral tooth strong; anterior muscular impression upon a raised base; ligament external.

Ptychodesma [p. 269].

Fourth line of description, for "Planorbis," read "Pectunculus."

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Plate 136.

Plate 137.

Plate 140.

FIGURE. PAGE.

11–13. Lingula anatina, Lam Moluccas. 11, dorsal; 12, ventral; 13, ventral. In fig. 11 a small portion of the liver and visceral sheath have been removed, to show the course of the stomach and intestine. In some specimens the whole of the viscera, except a portion of the liver, are concealed by the ovaries. In fig. 13 the front half of the ventral mantle-lobe is raised, to show the spiral arms; the black spot in the centre is the mouth, with its upper and lower lips, one fringed, the other plain. The mantle-fringe has been omitted in figs. 11, 13. *a a*, anterior adductors; *a'*, posterior adductor; *p p*, external adjusters; *p' p'*, central adjusters; *r r*, anterior retractors (the anterior occlusors of Hancock); *r' r' r'*, posterior adjusters; *c*, capsule of pedicle; *n n*, visceral sheath; *o*, œsophagus; *s*, stomach; *l*, liver; *i*, intestine; *v*, vent; *b*, branchial vessels; *m'*, mantle-margin; *m*, inner lamina of mantle-margin retracted, showing bases of setæ; *s*, setæ. . 341

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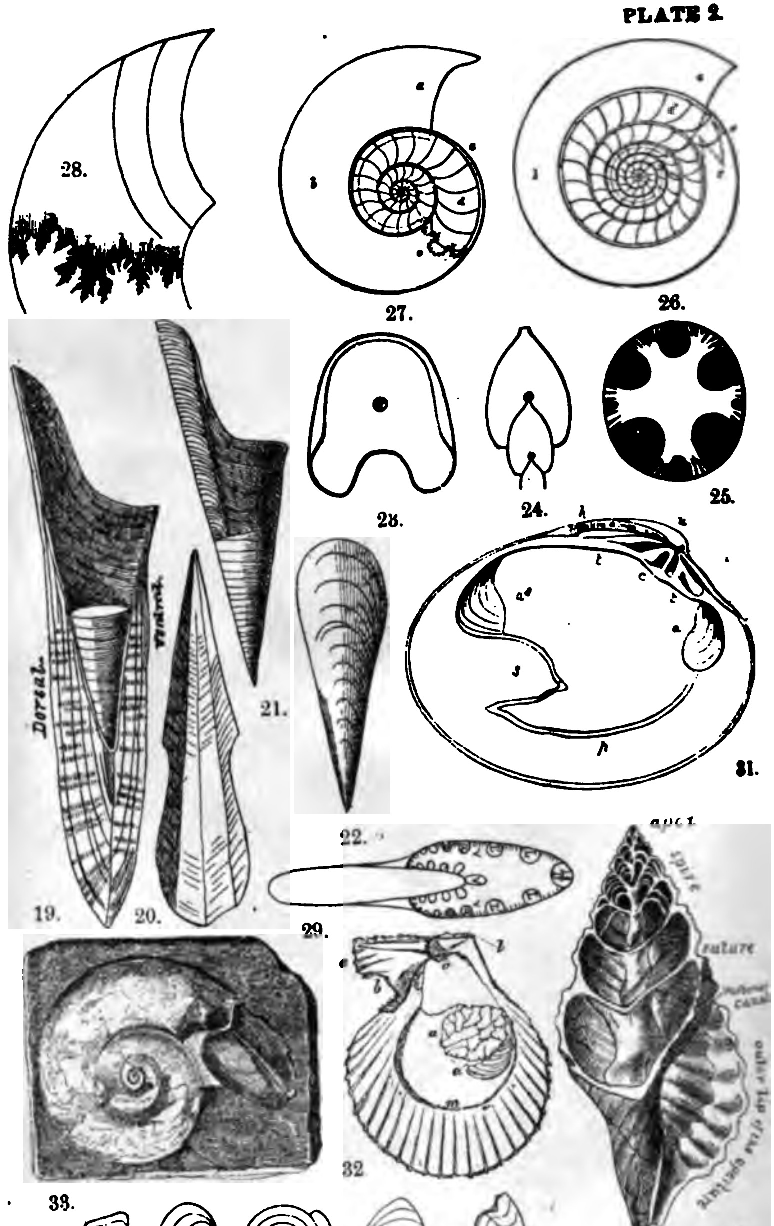
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posterior canal
outer lip of last spiral
anterior canal
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PLATE 8.


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50.
Dorsal Margin.
Posterior side.
Anterior side.
Ventral margin or base.
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PLATE 4.

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PLATE 5.

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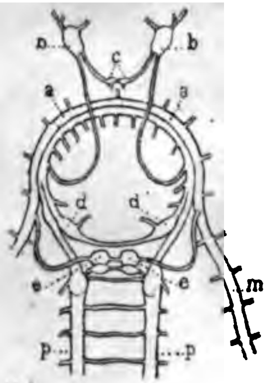

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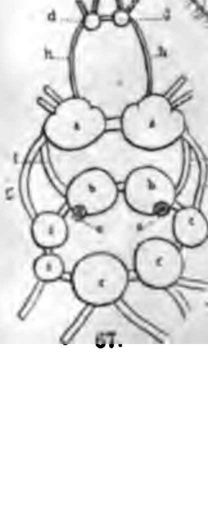

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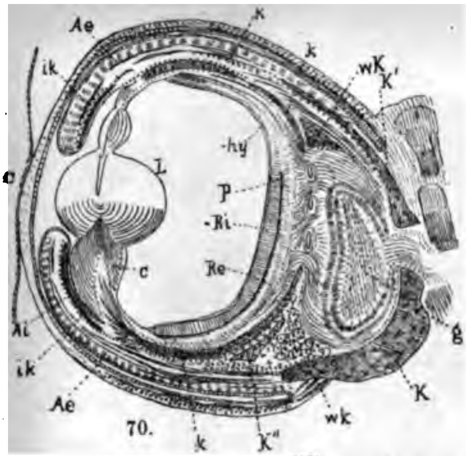

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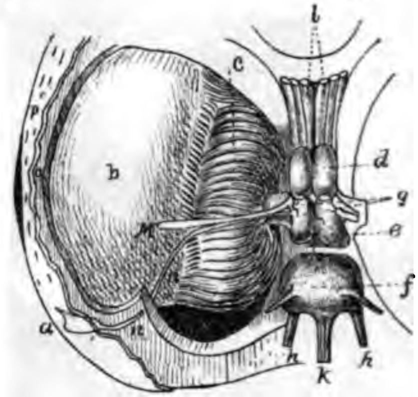

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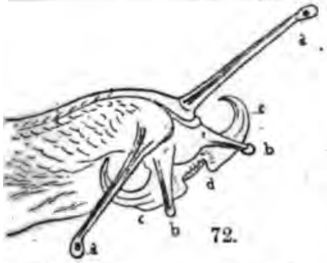

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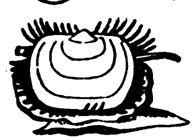
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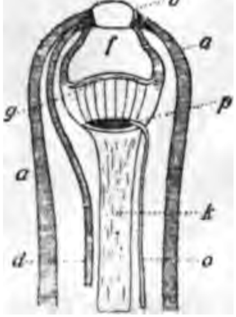

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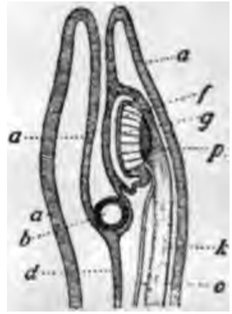

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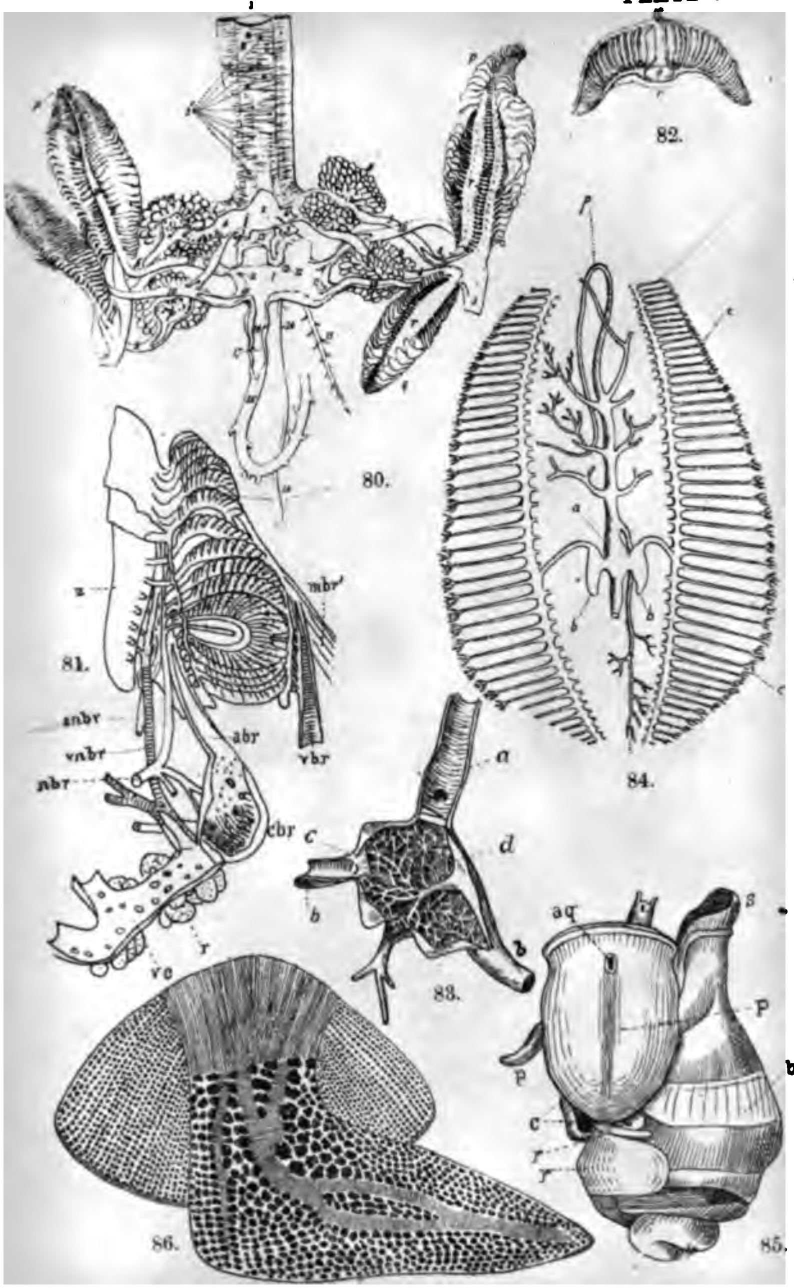

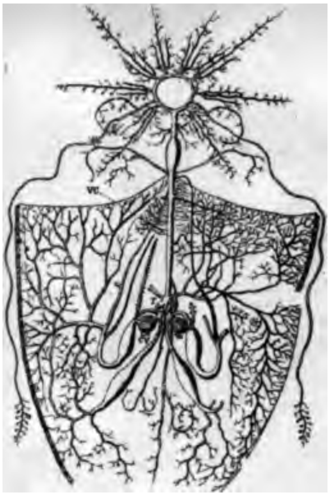

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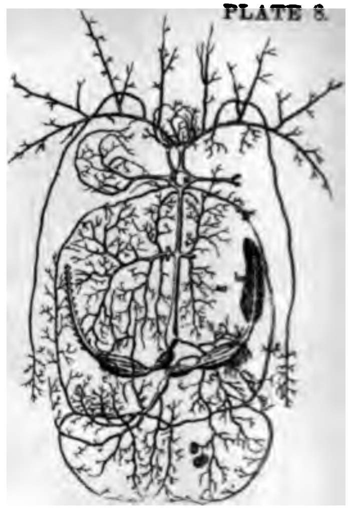

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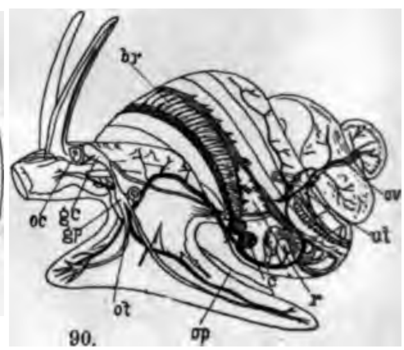

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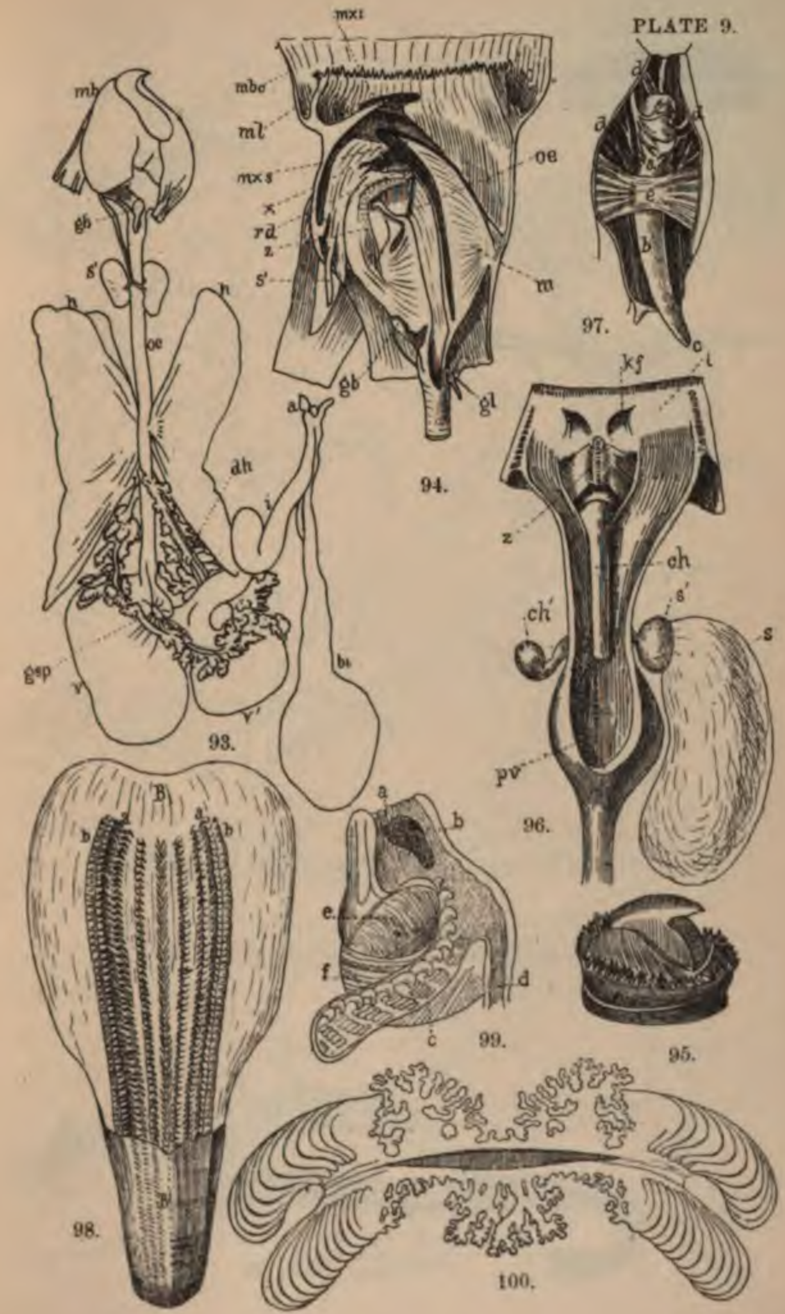
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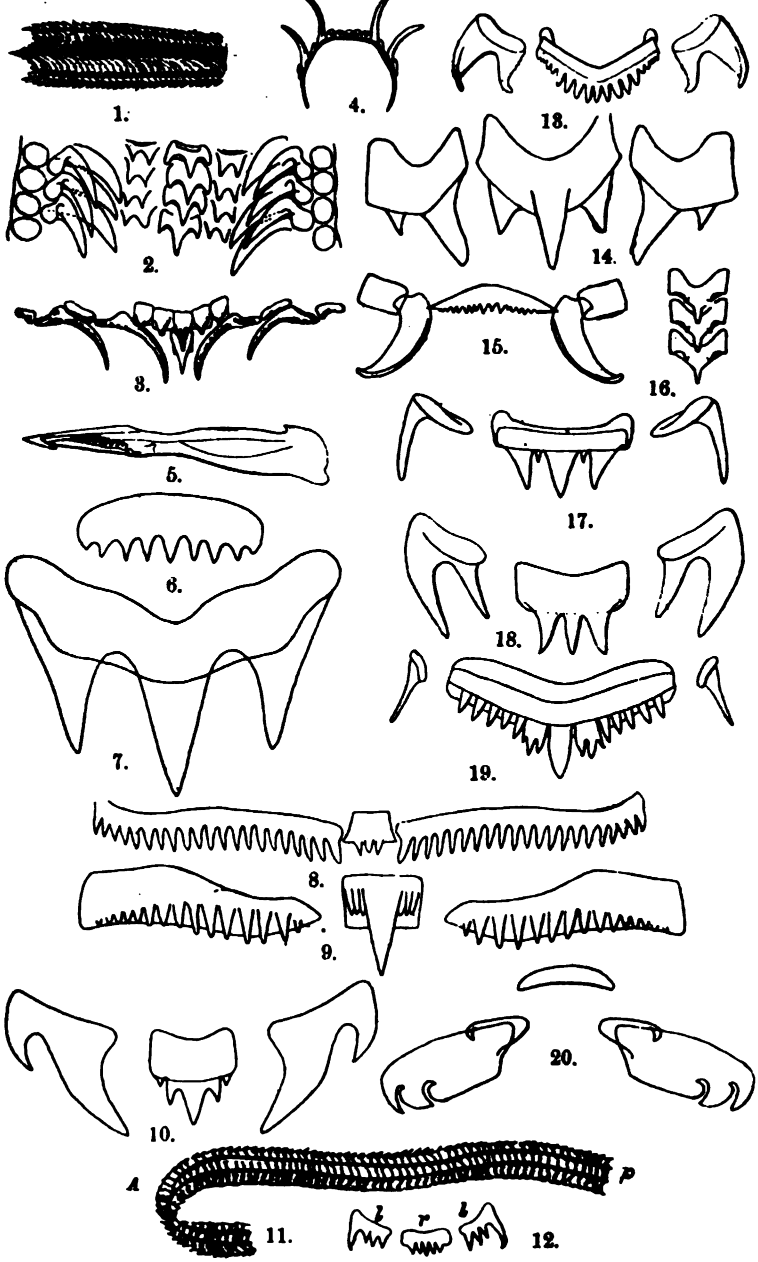

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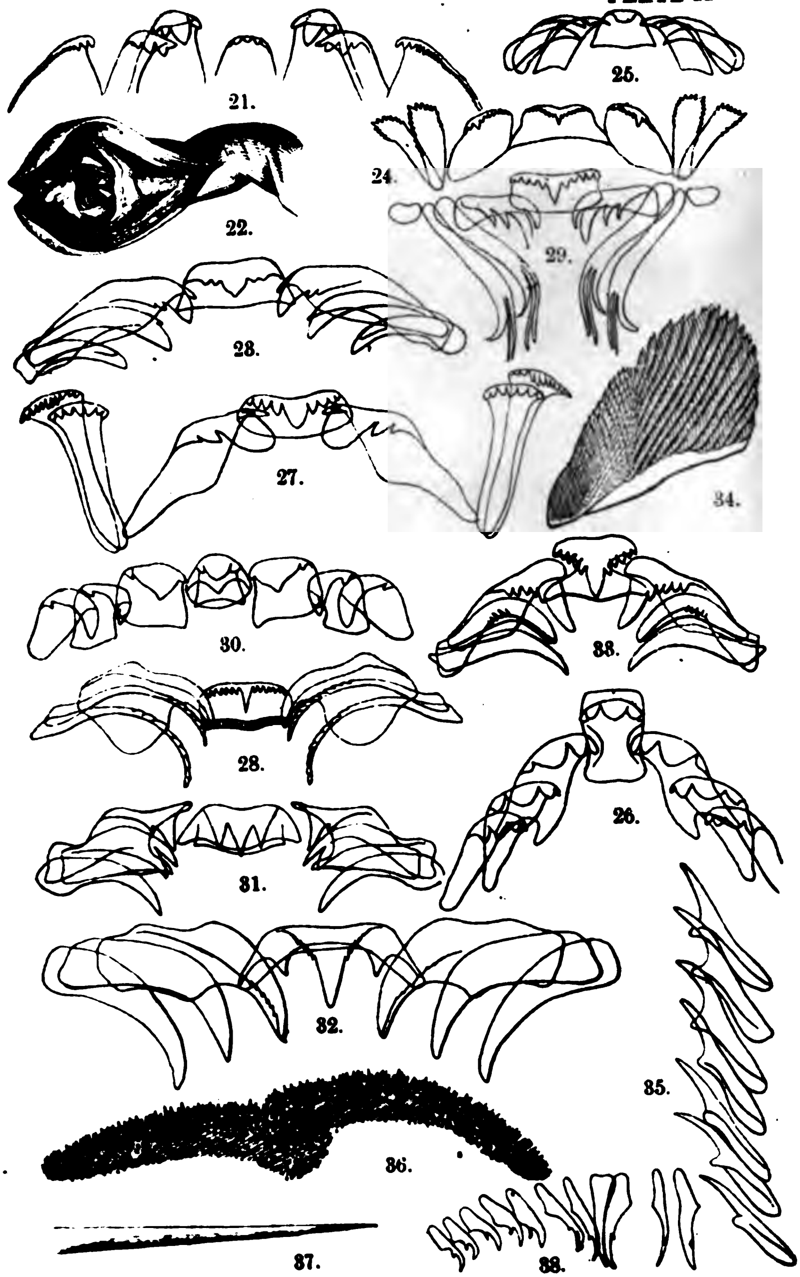

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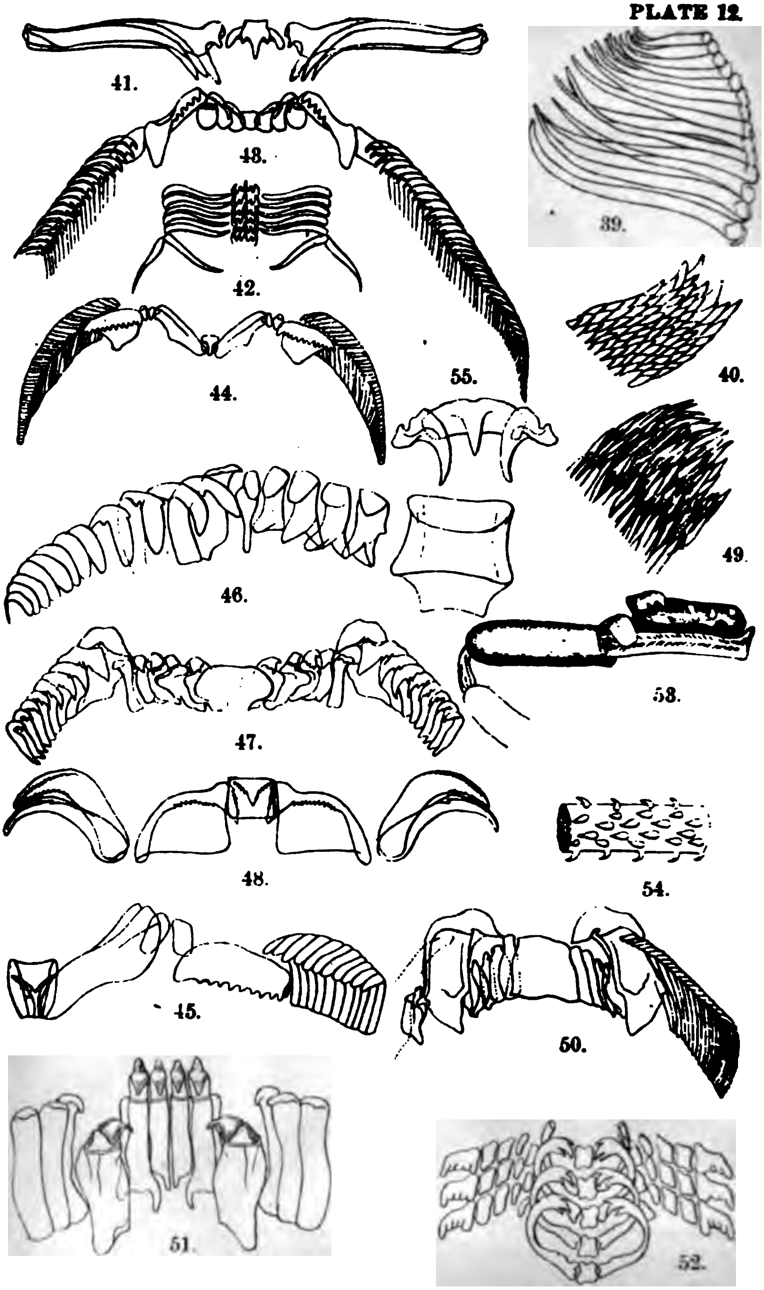

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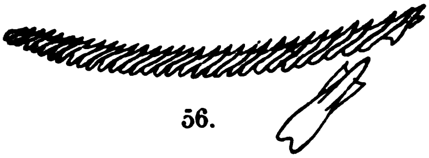

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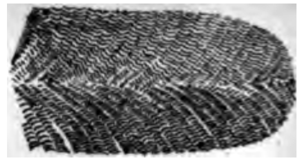

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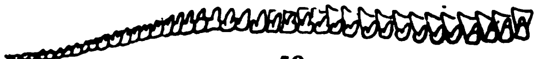

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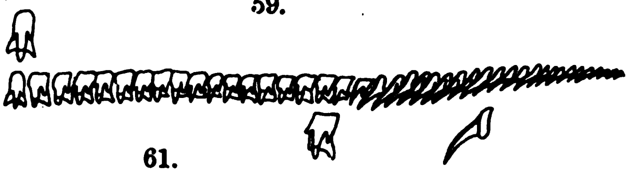

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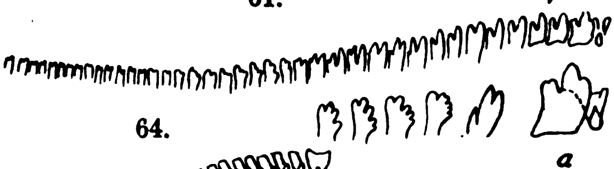

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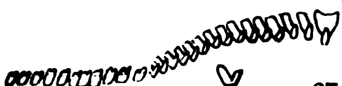

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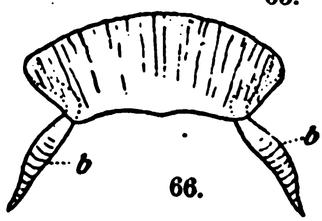

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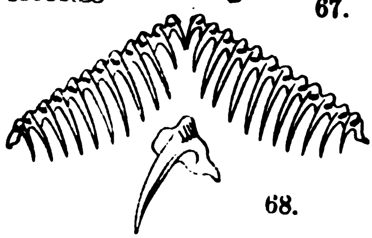

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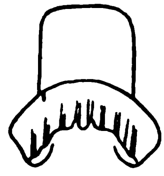

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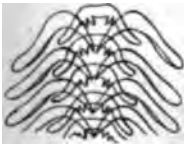

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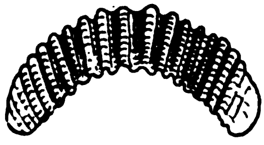

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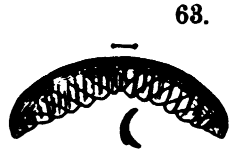

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PLATE 14.

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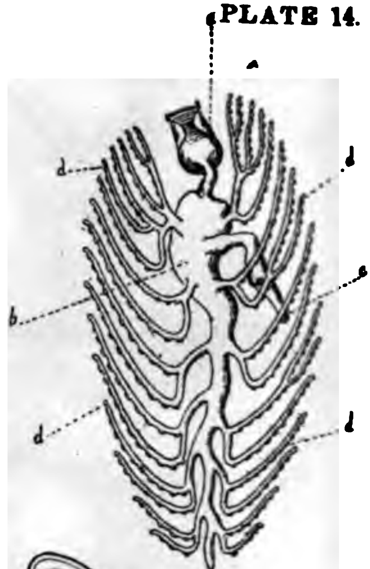

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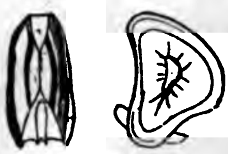

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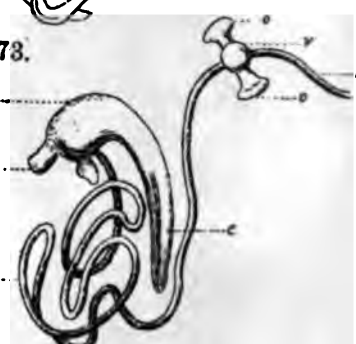

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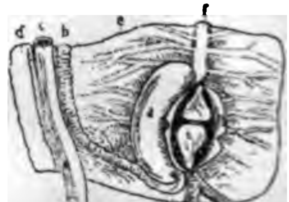

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PLATE 15.

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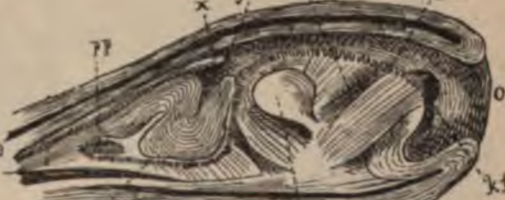

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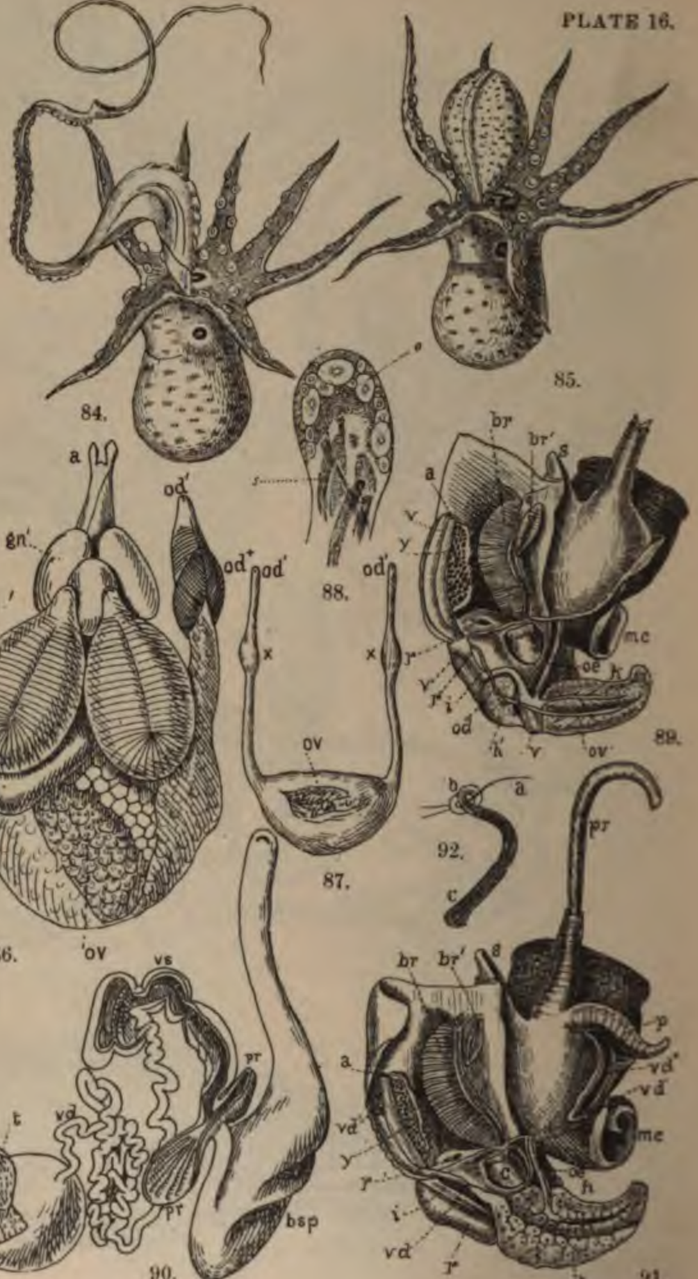
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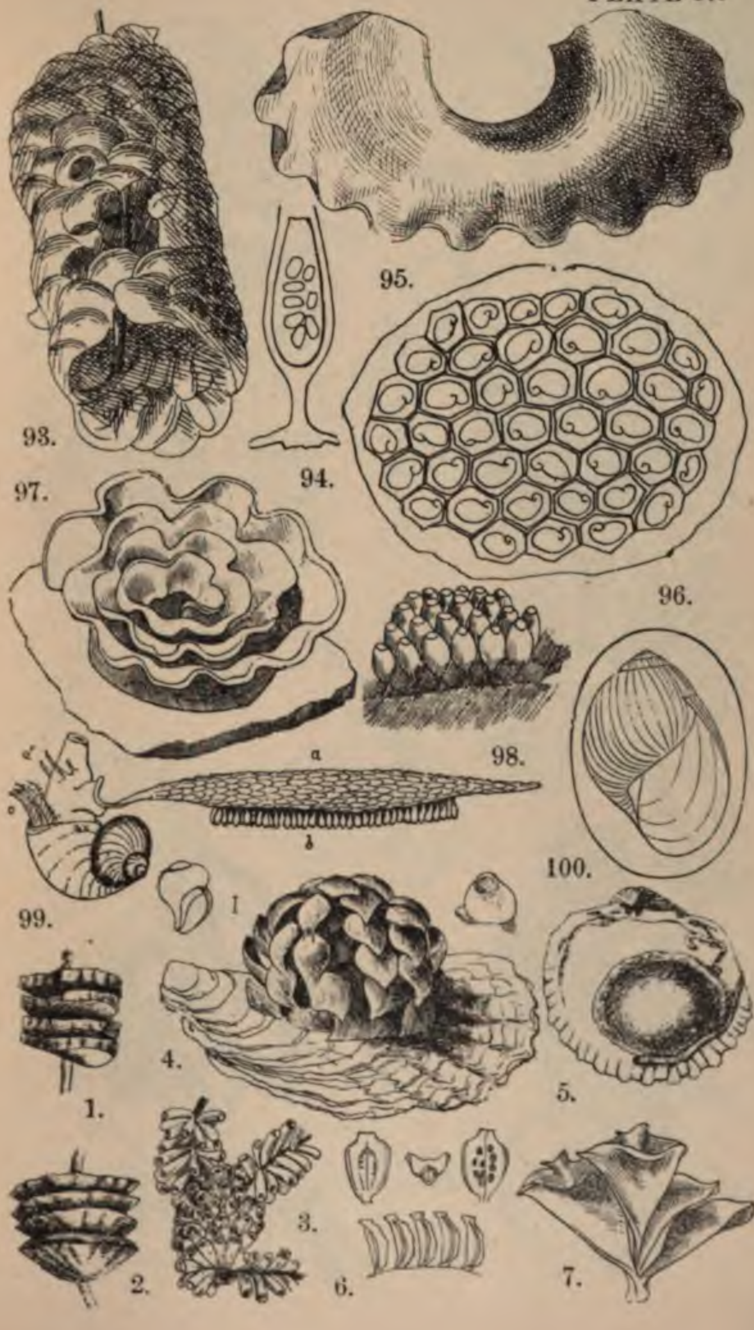
PLATE 17.



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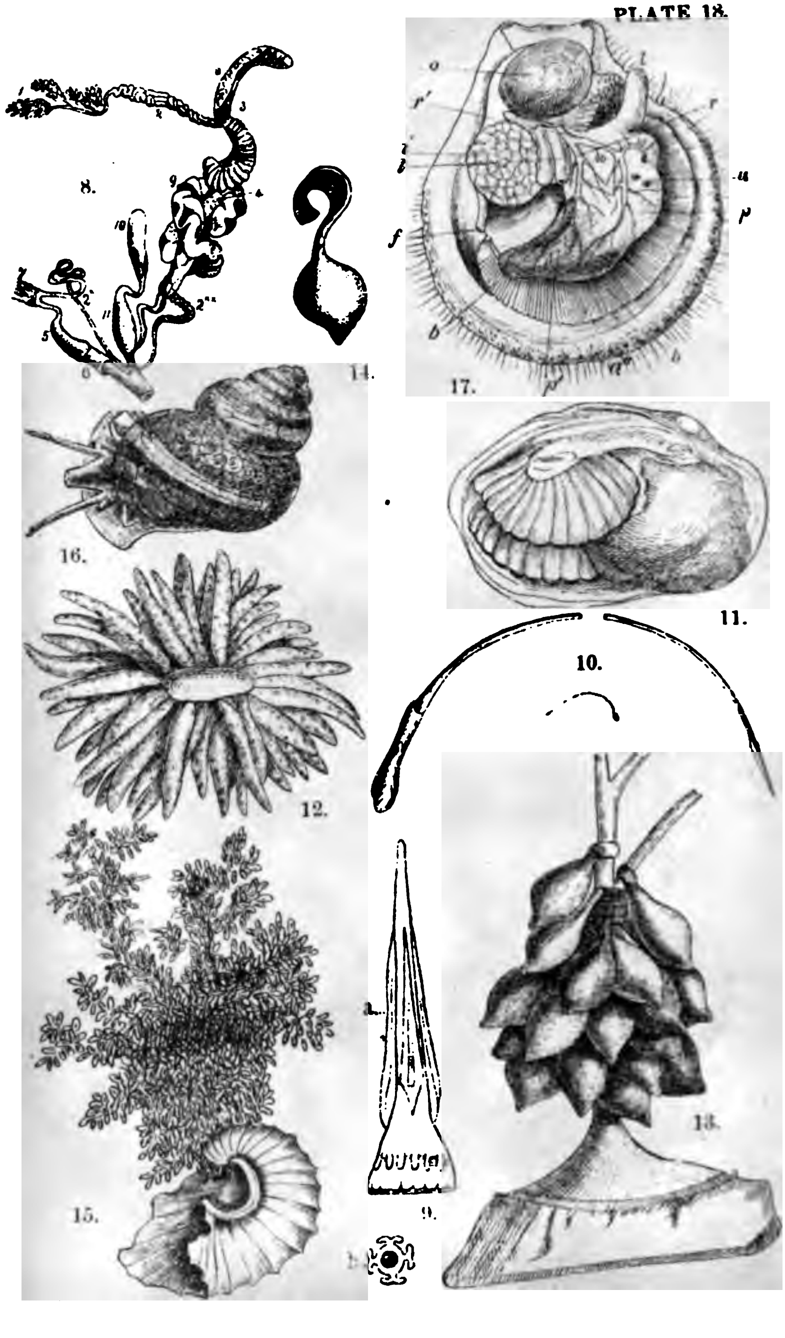

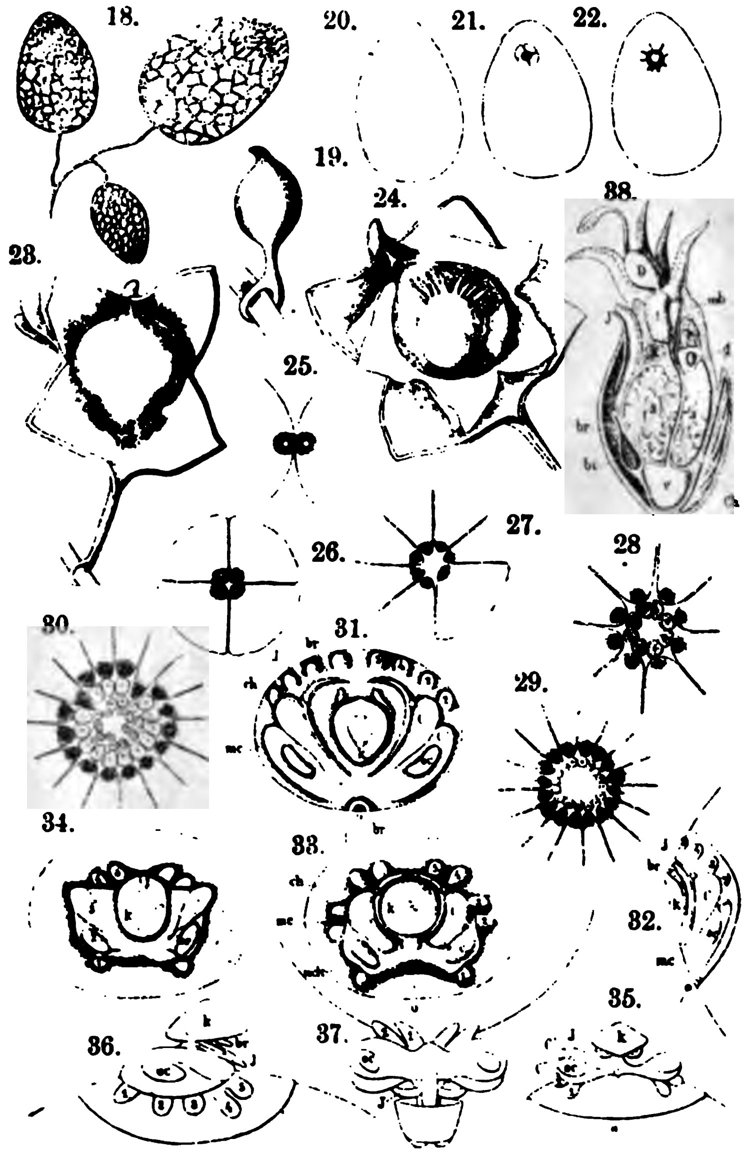
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PLATE 20.

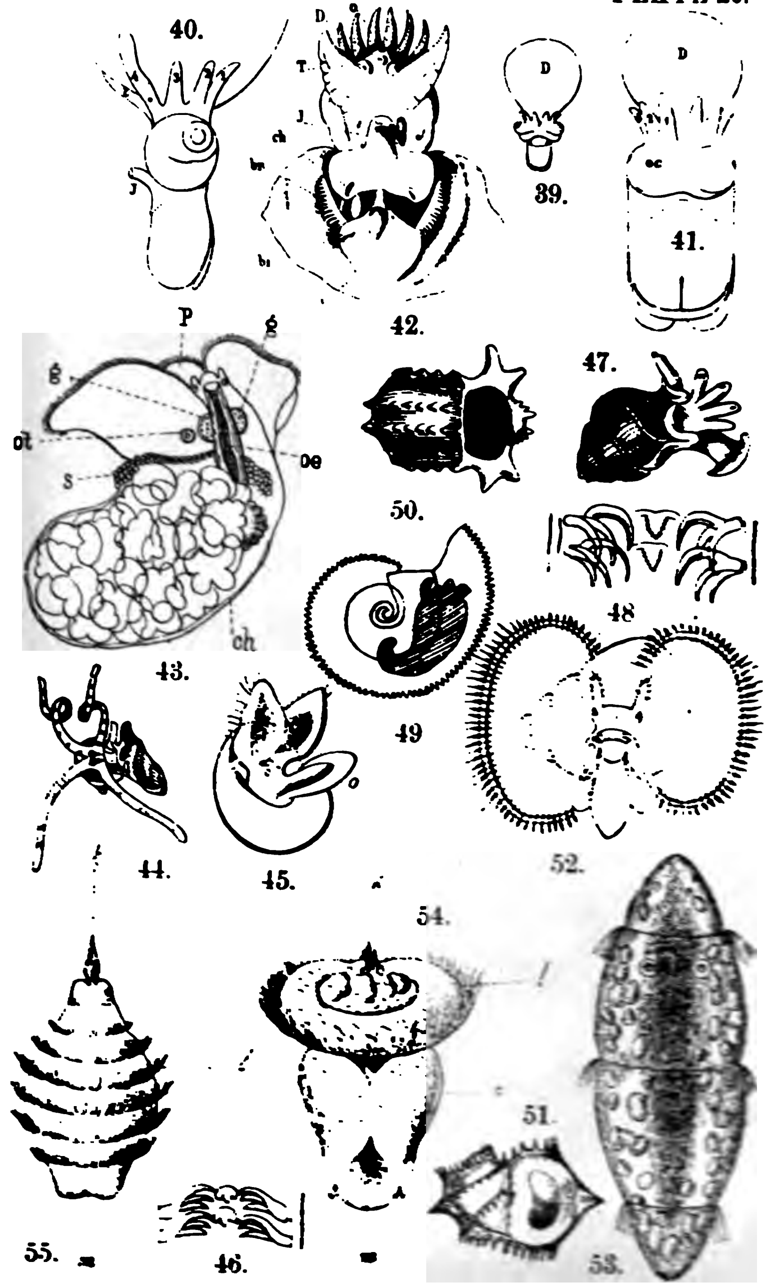

PLATE 21.

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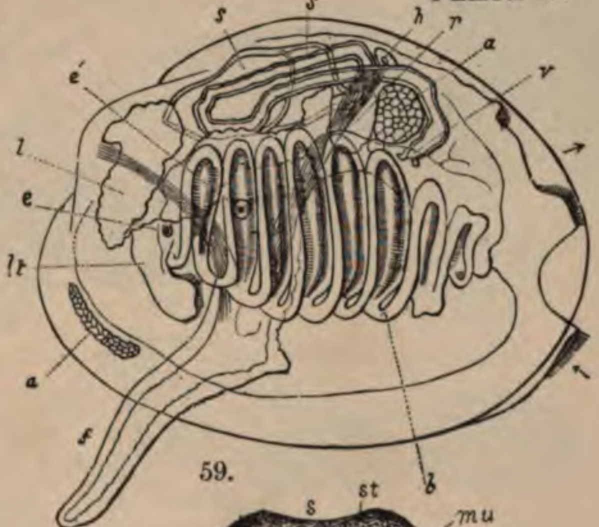

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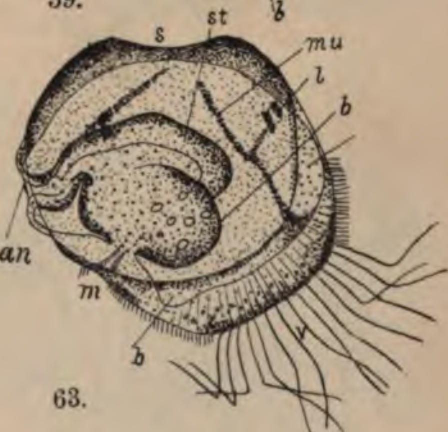

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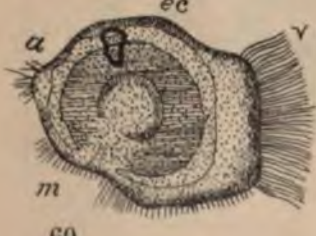

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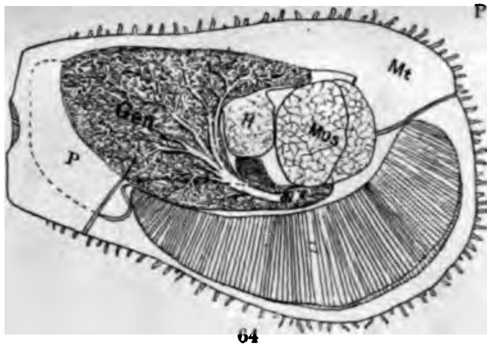

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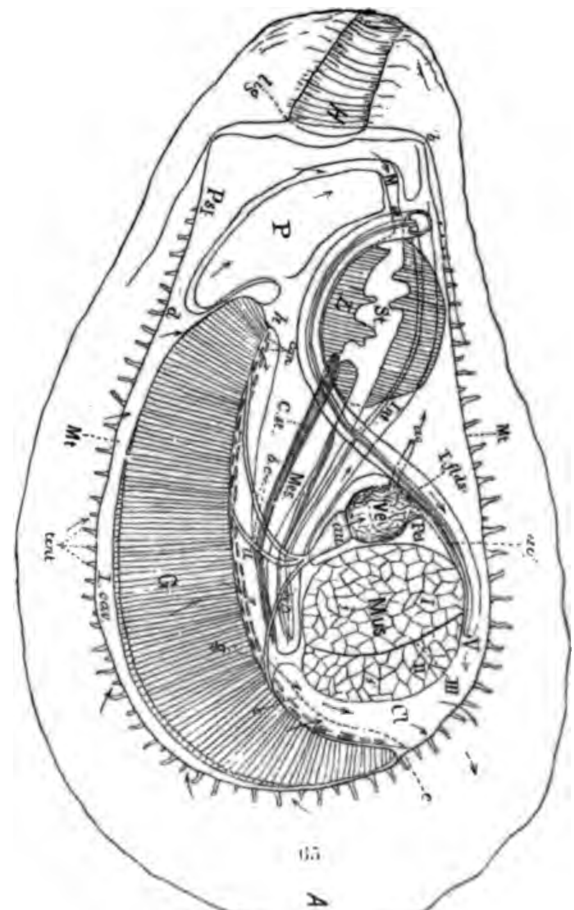

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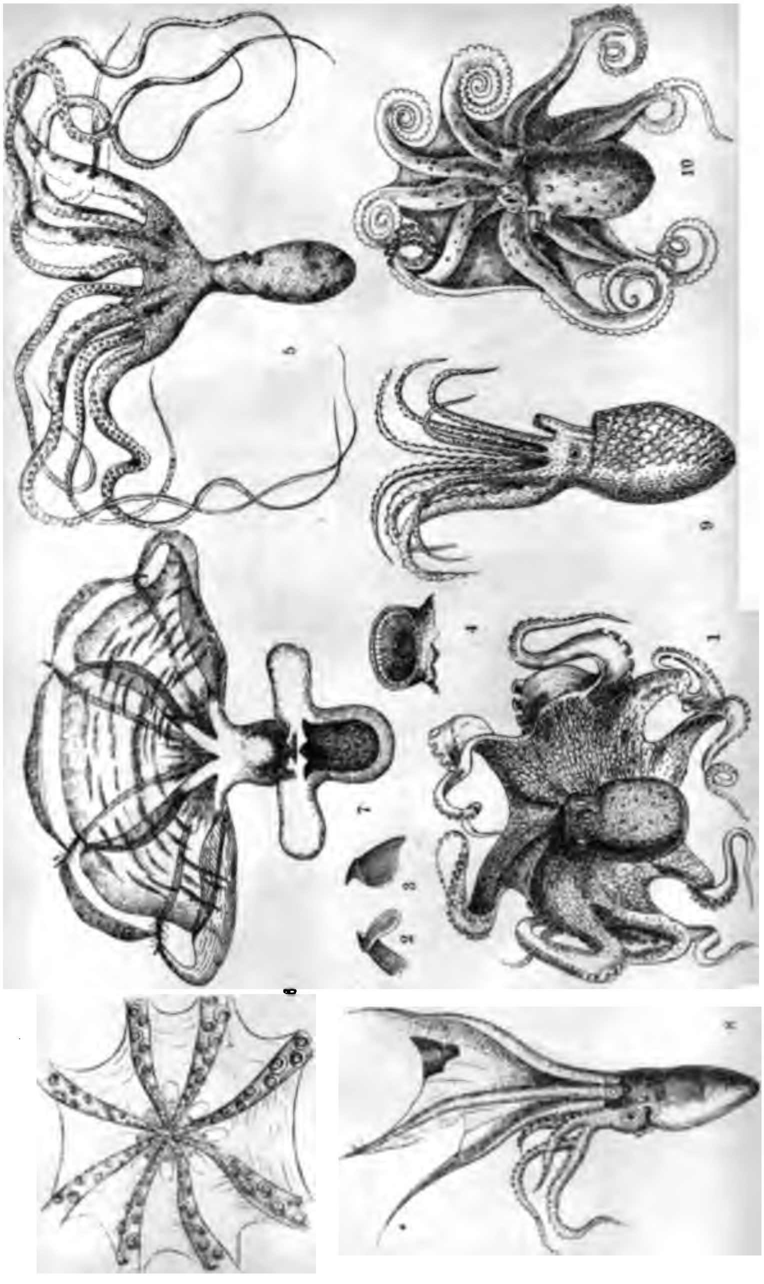
PLATE 23.



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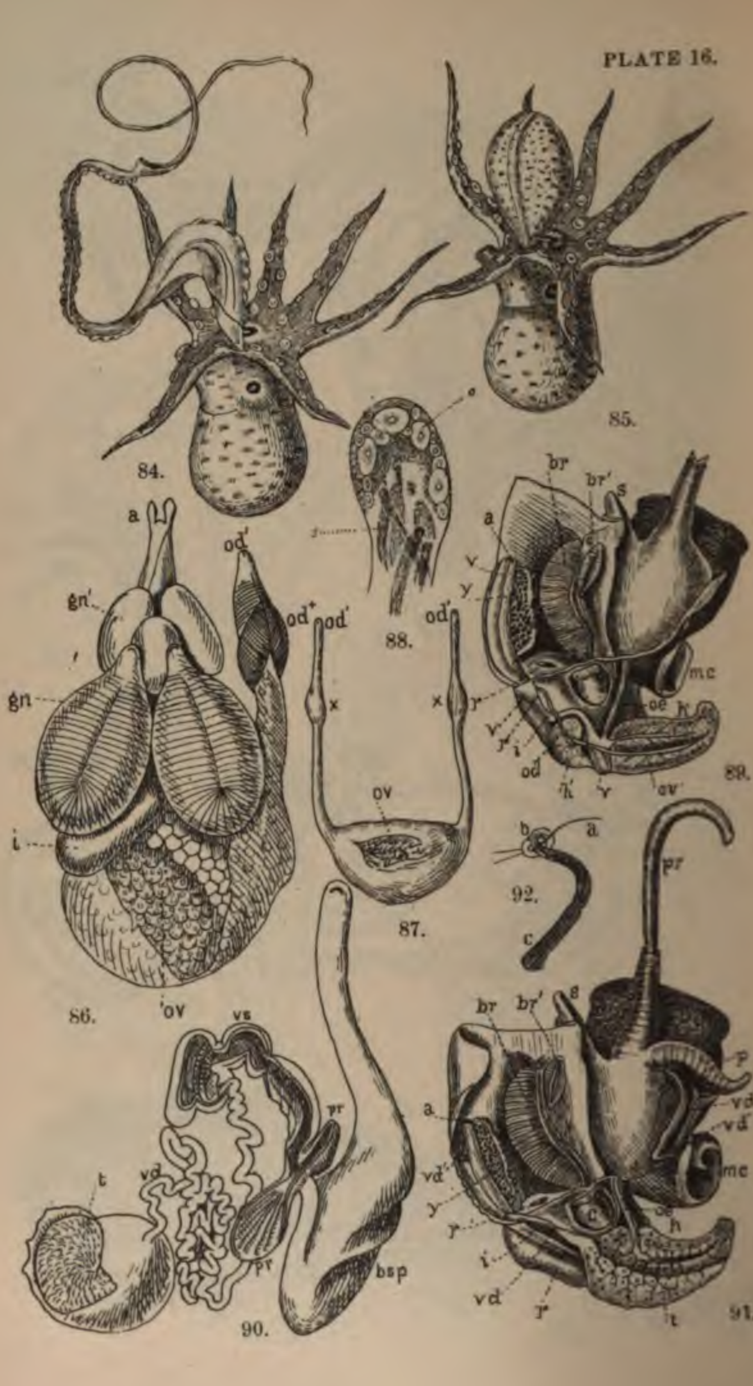
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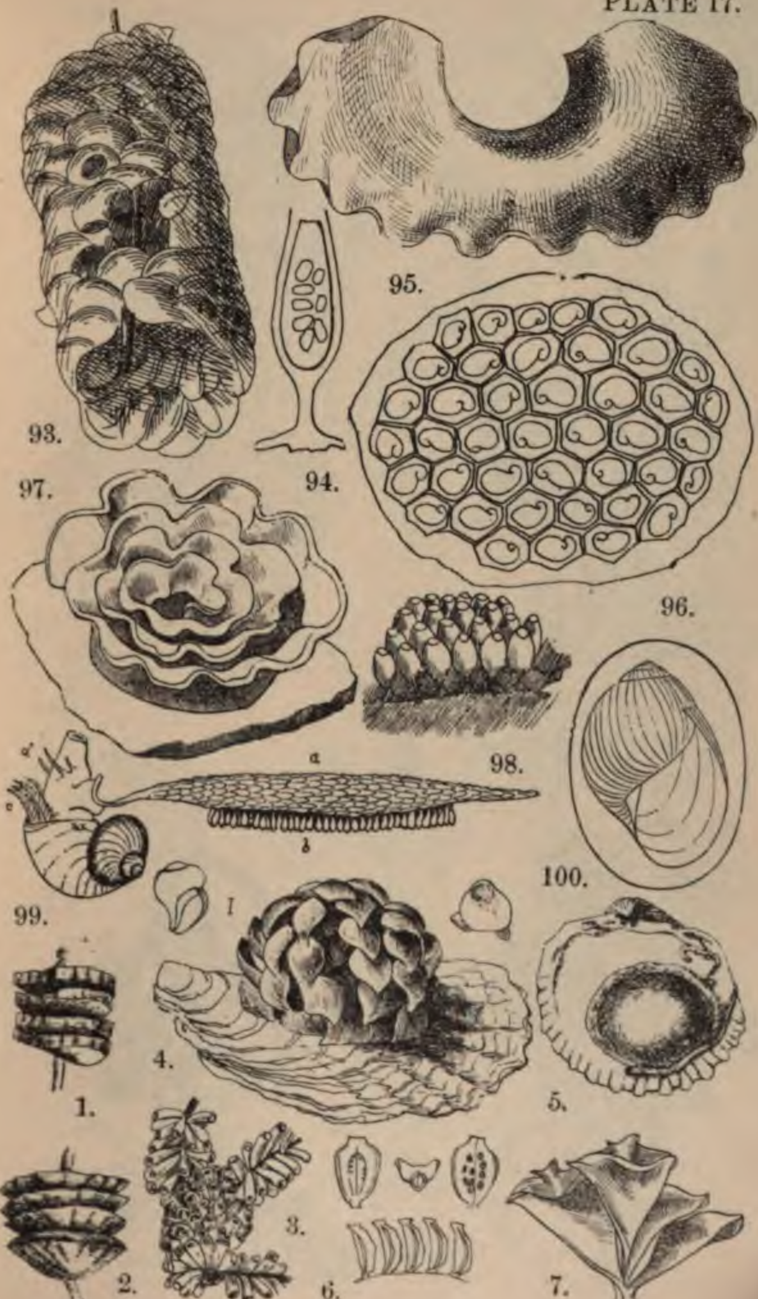
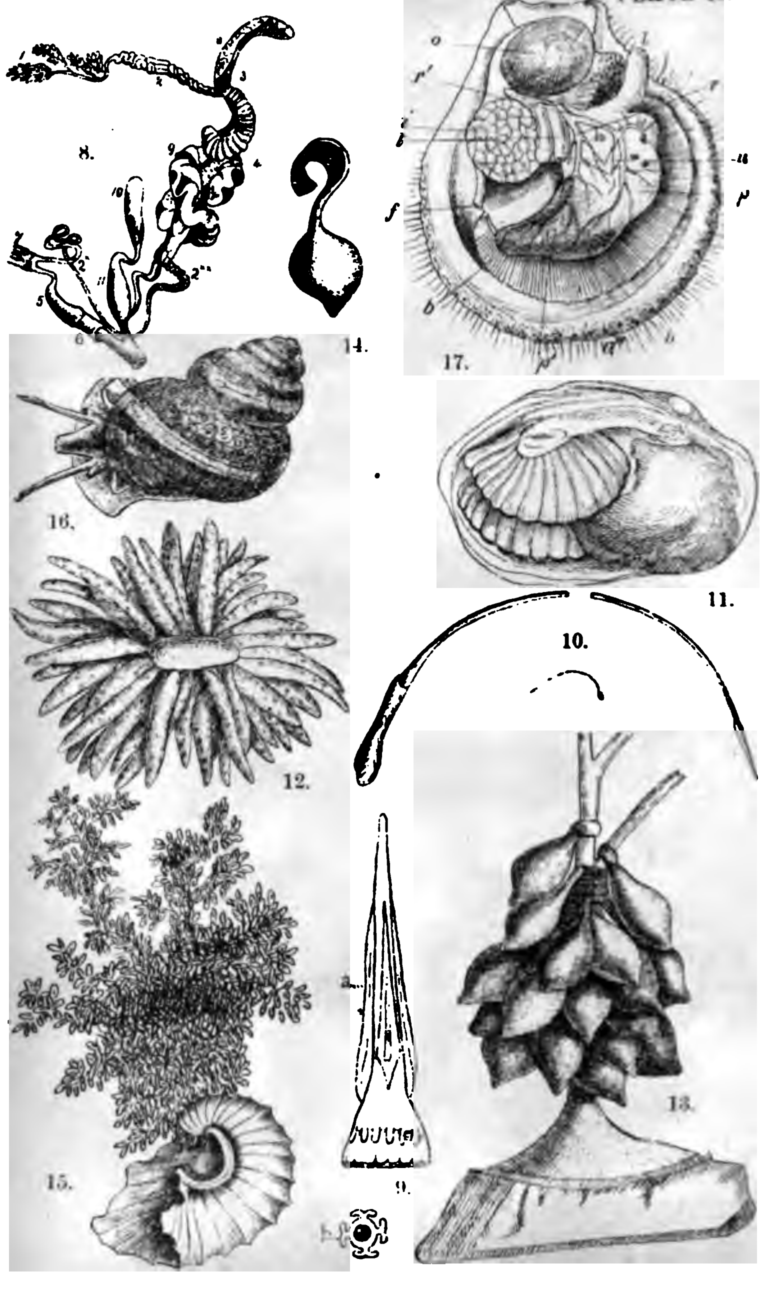


PLATE 18.



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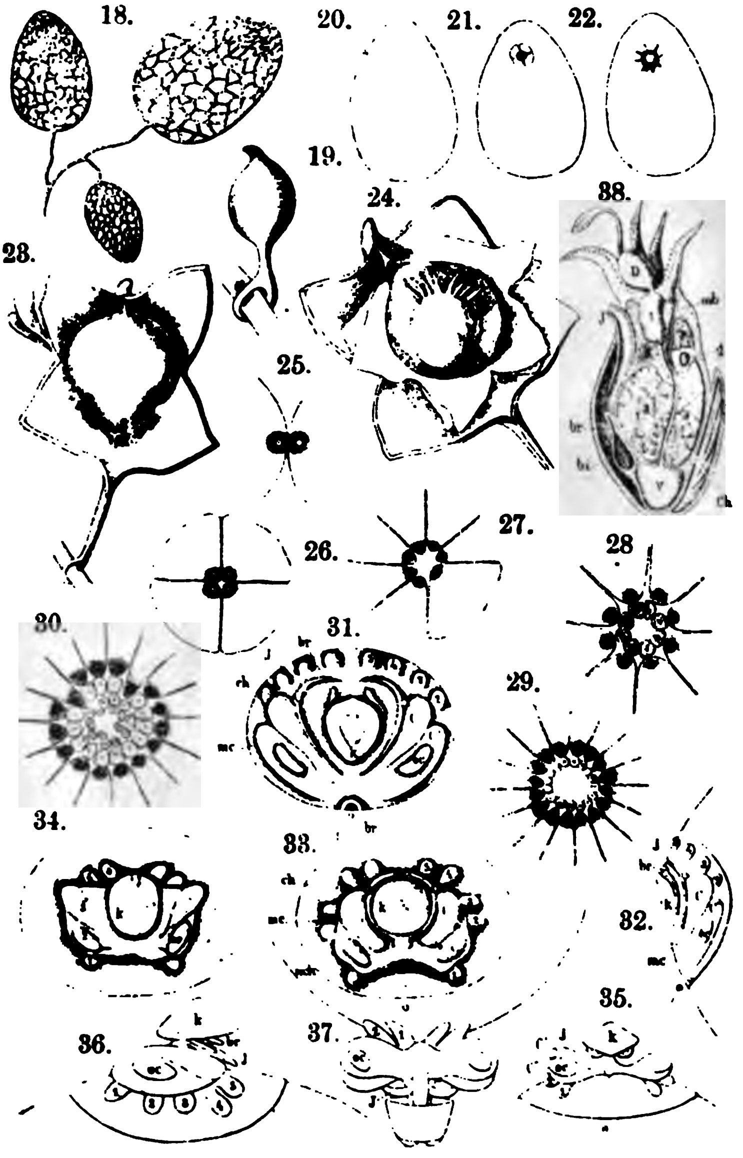

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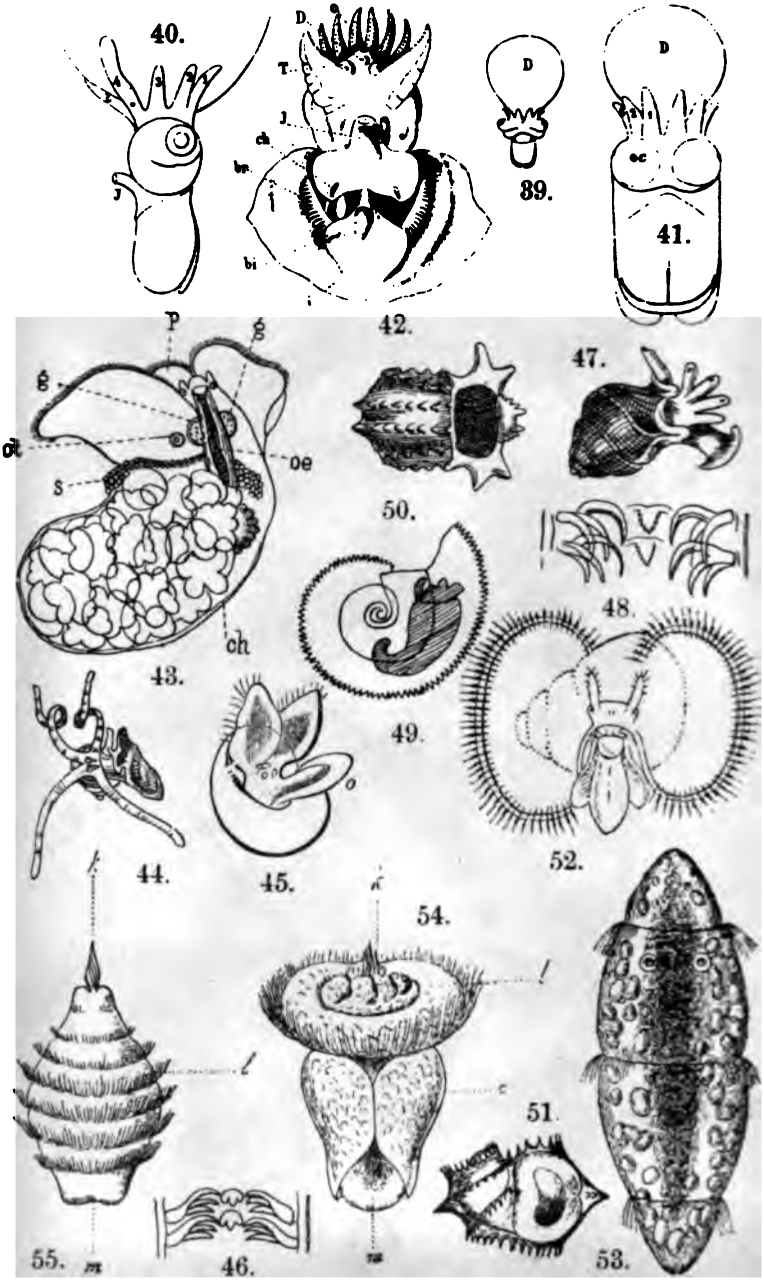

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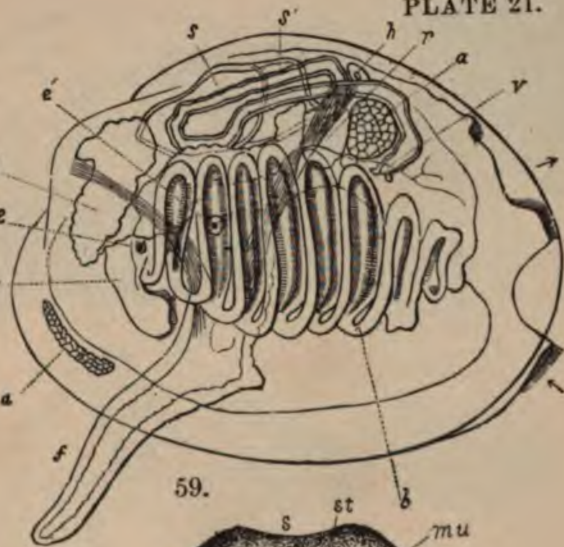

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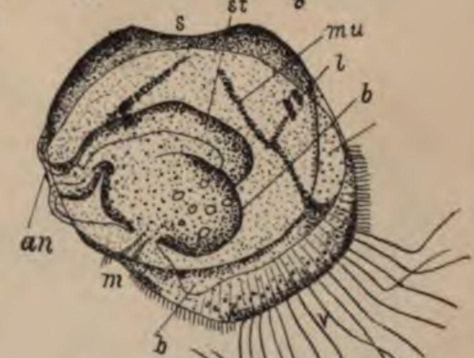

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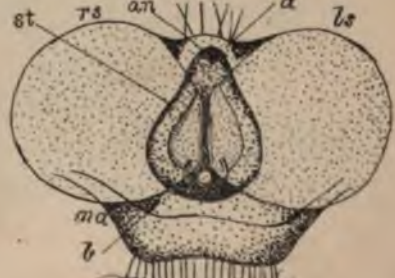

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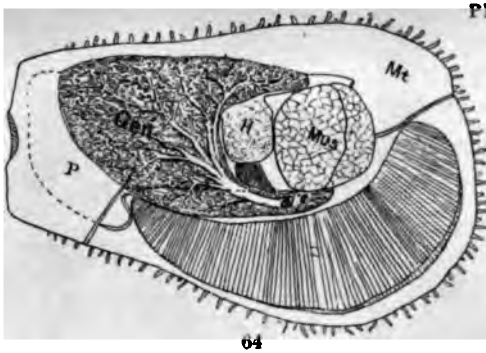

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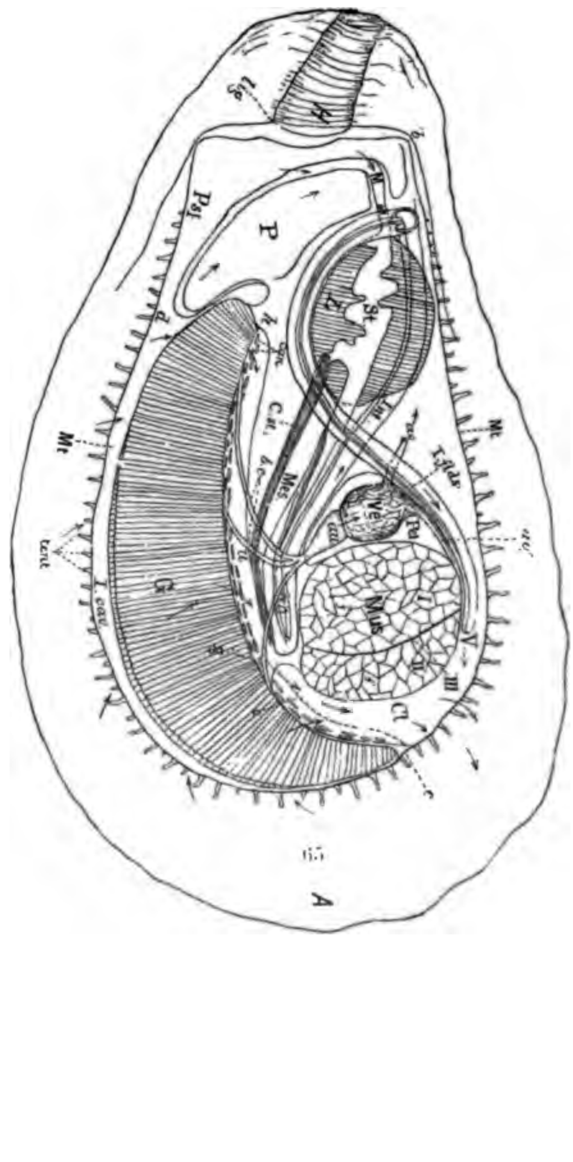

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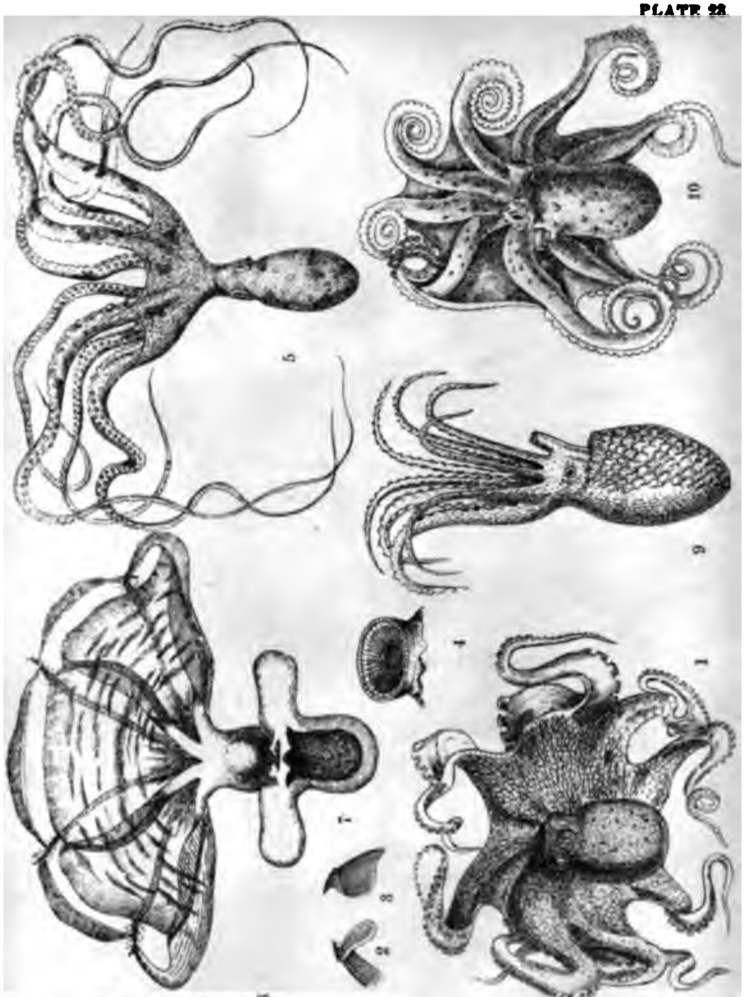

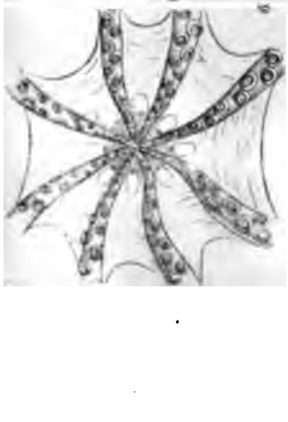

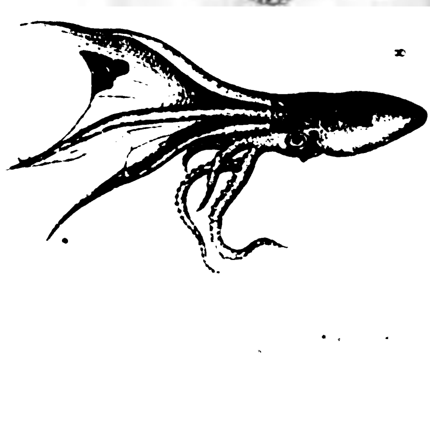

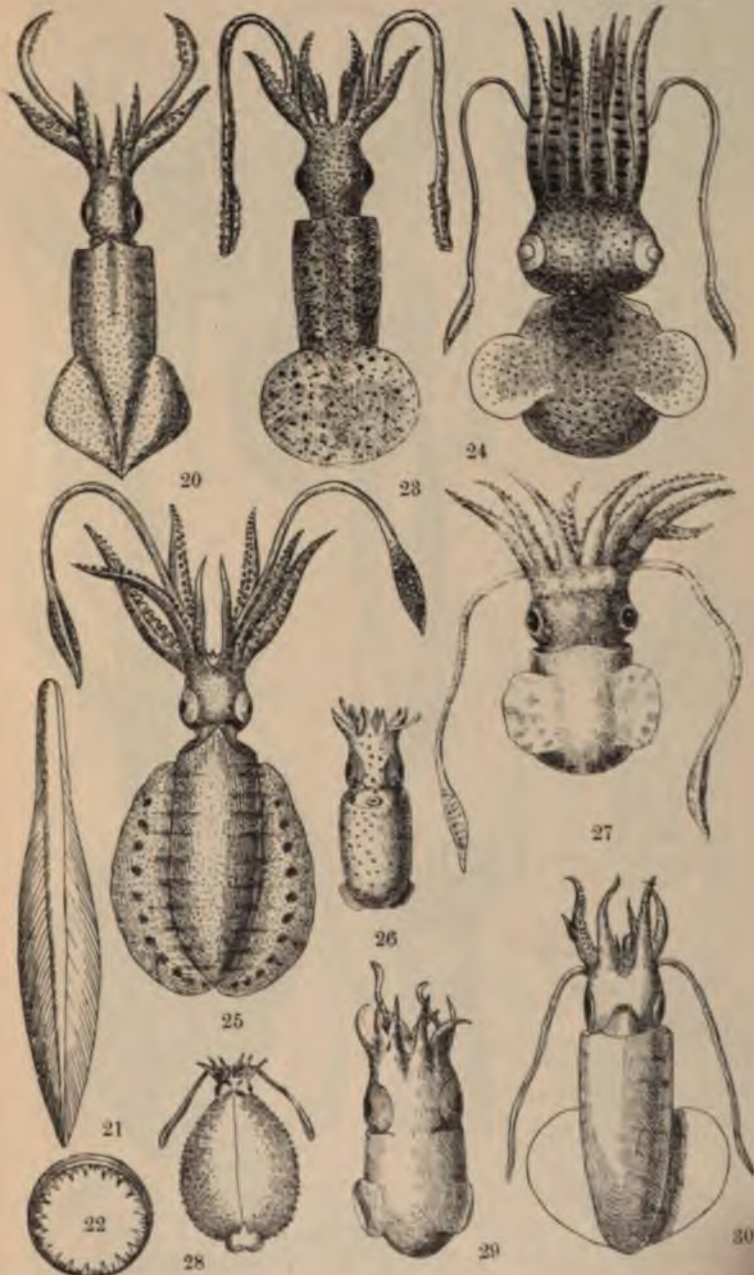

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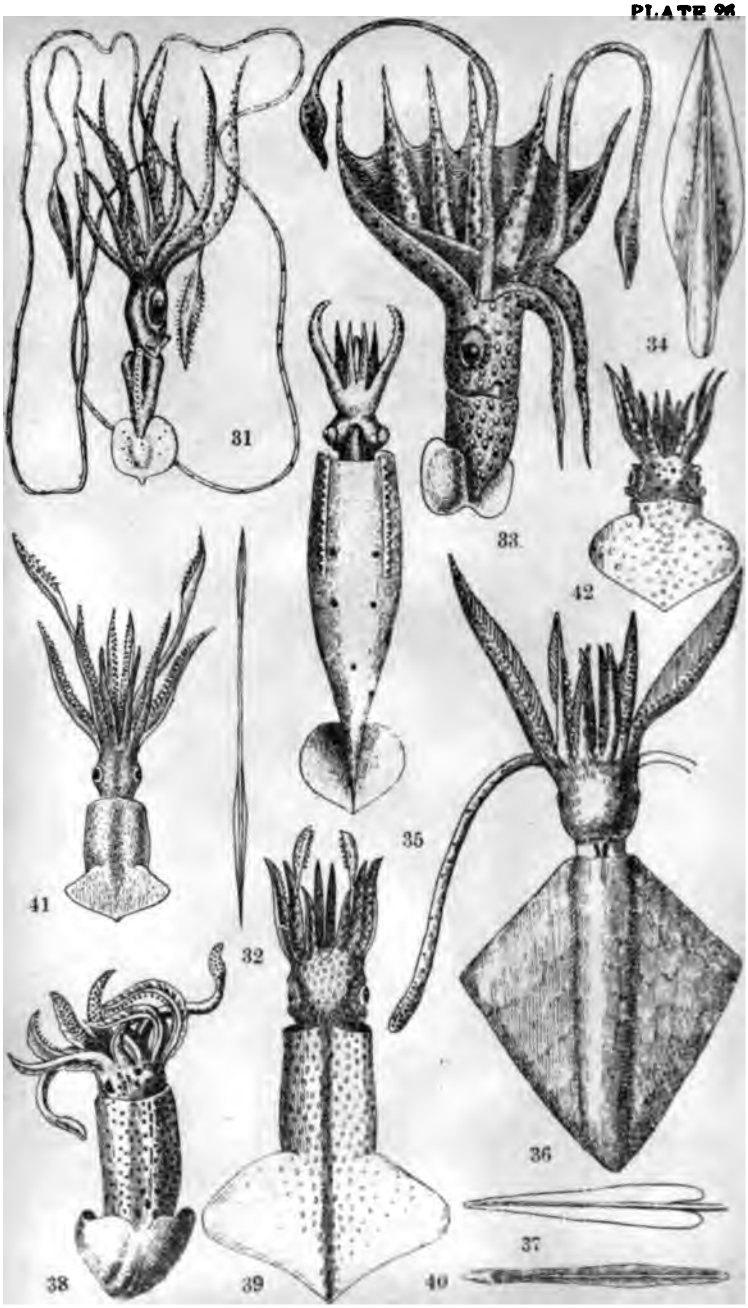

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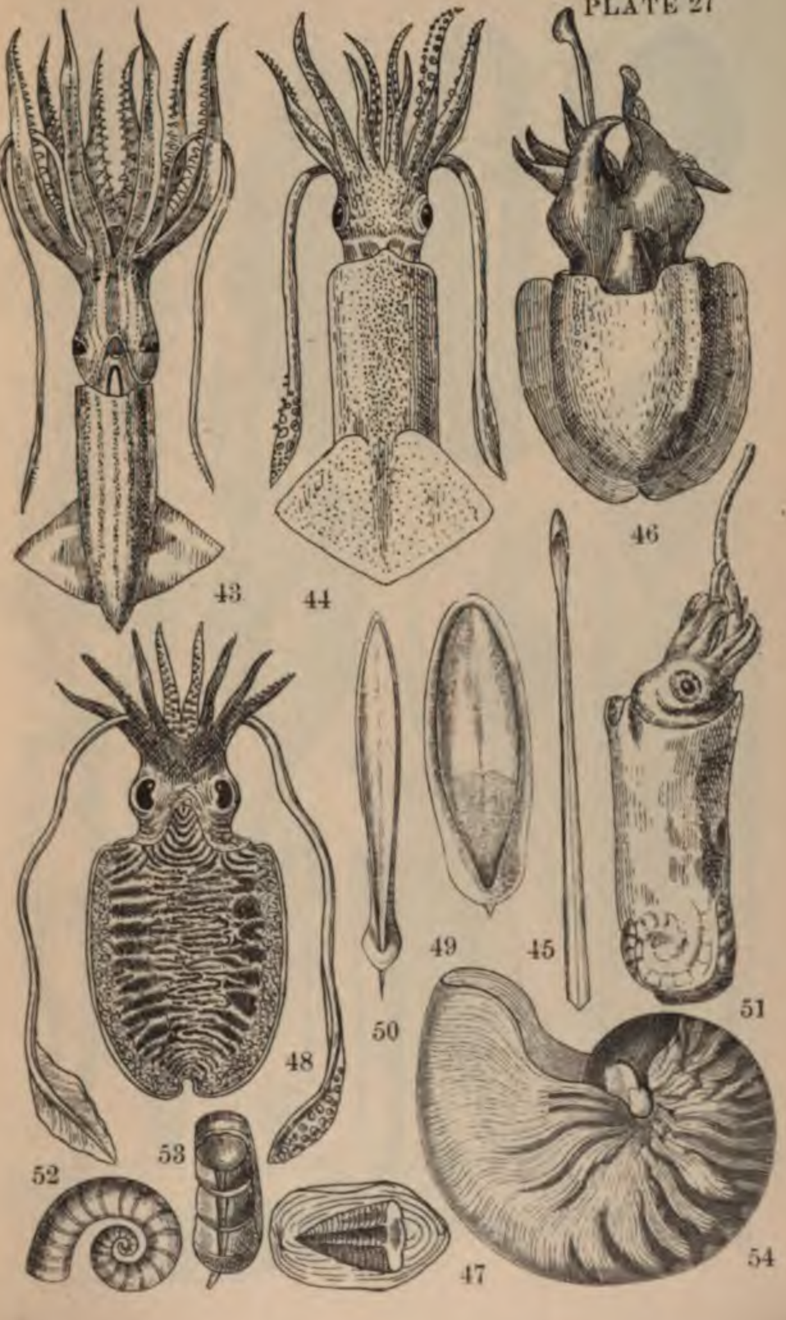

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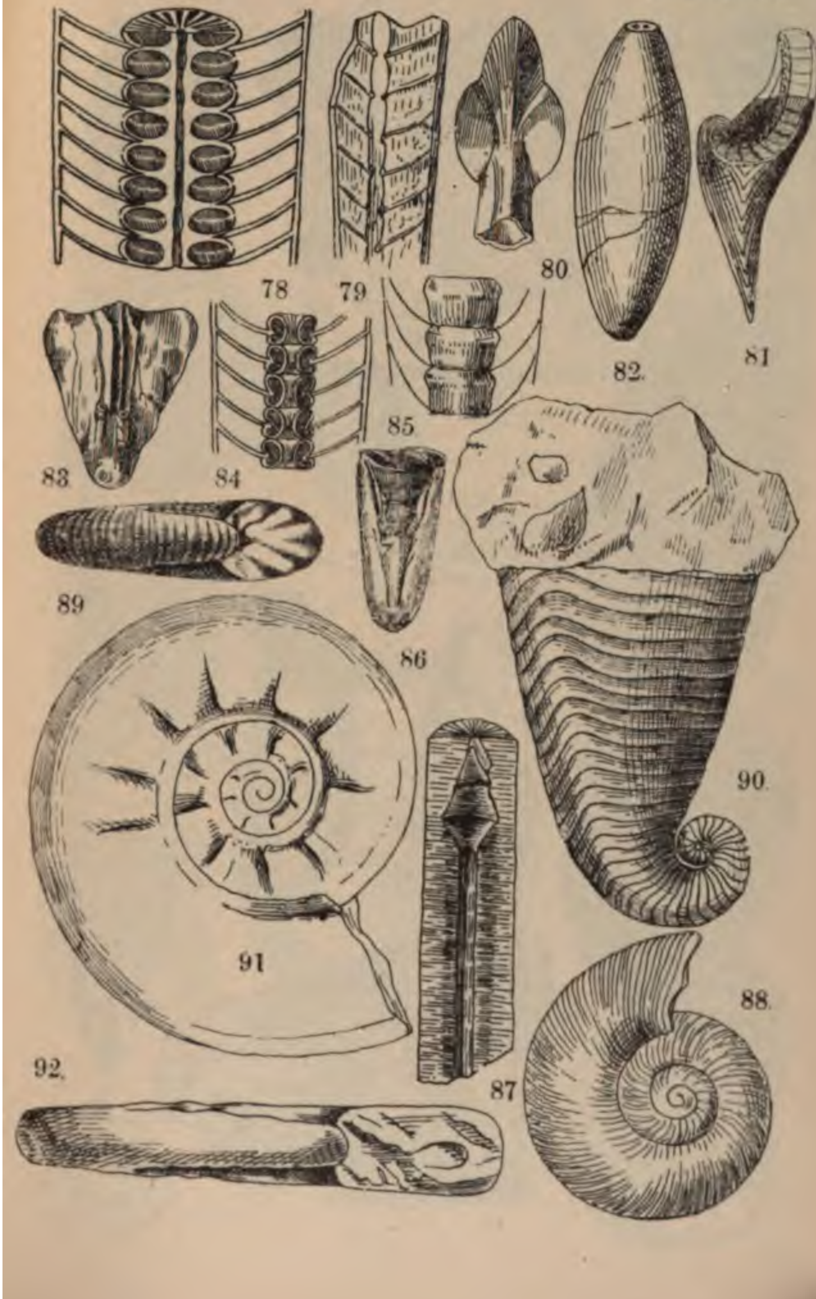

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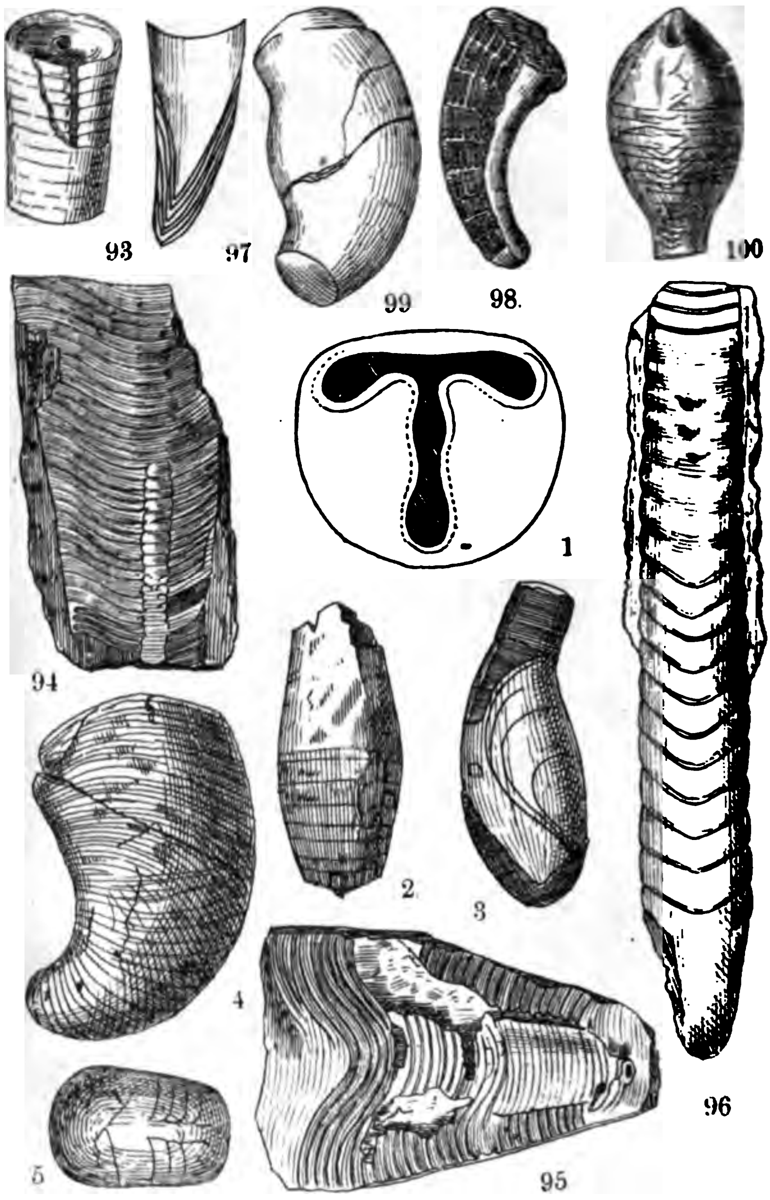

PLATE 31.

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PLATE 34.

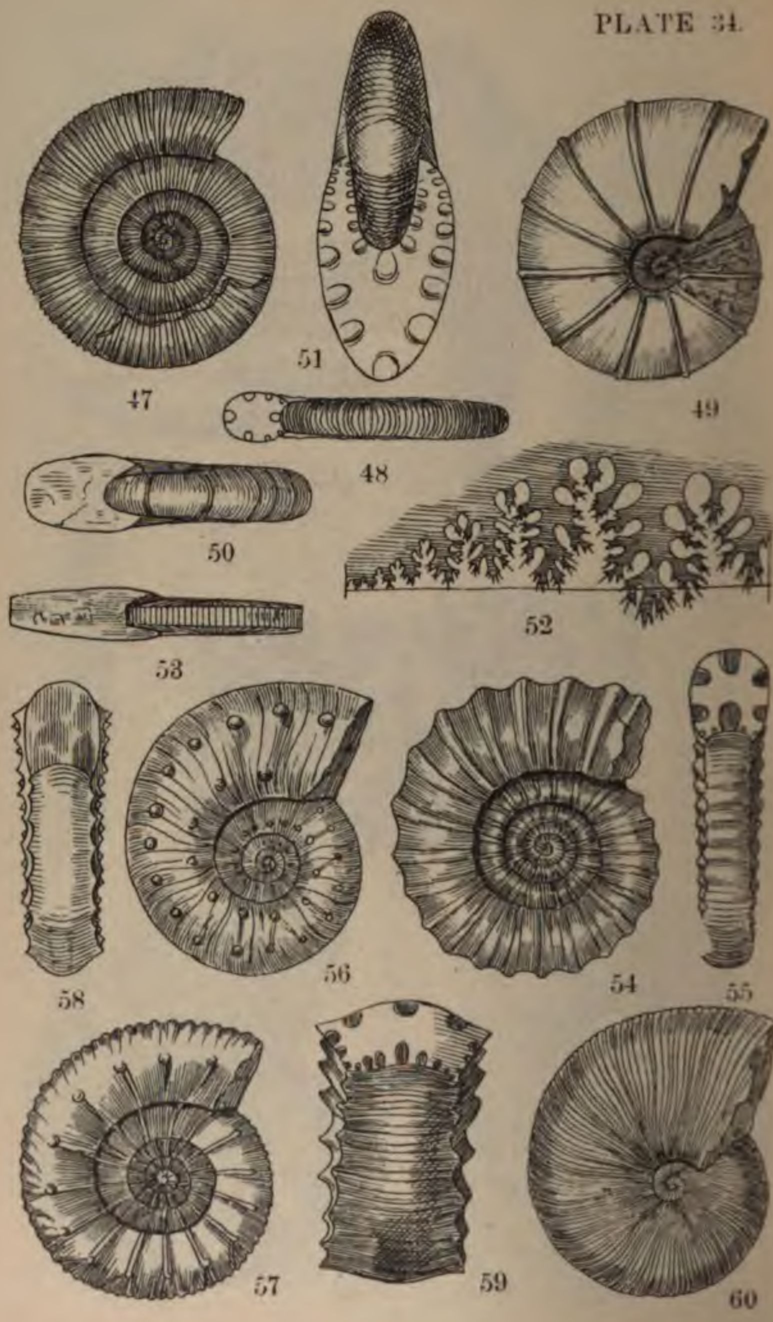

PLATE 35.

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PLATE 38.

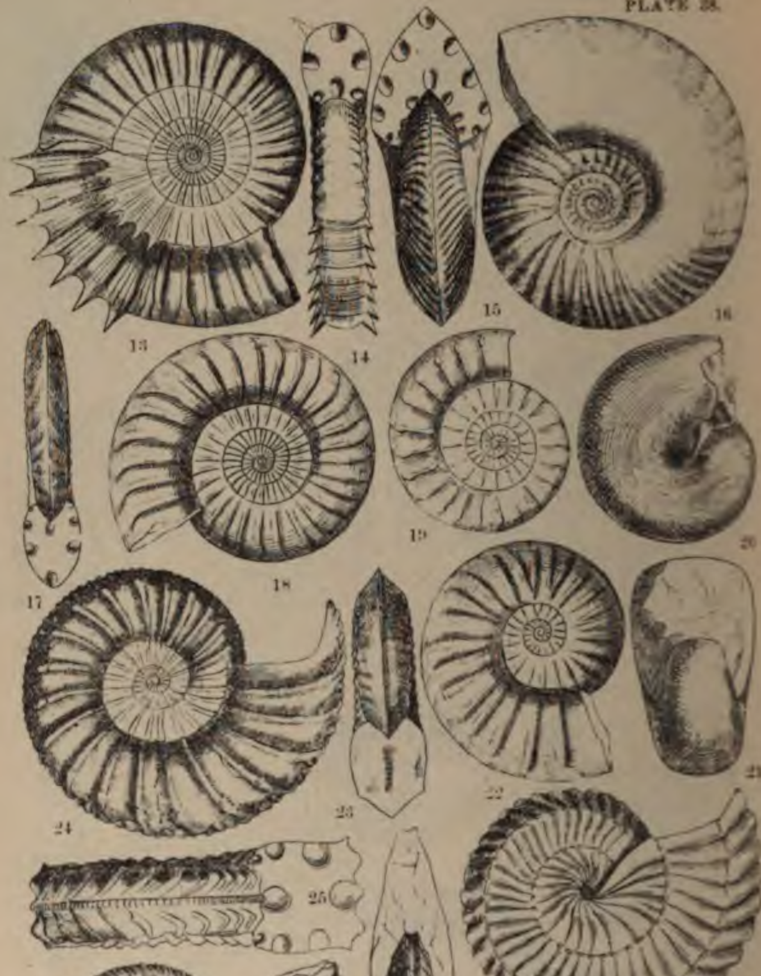
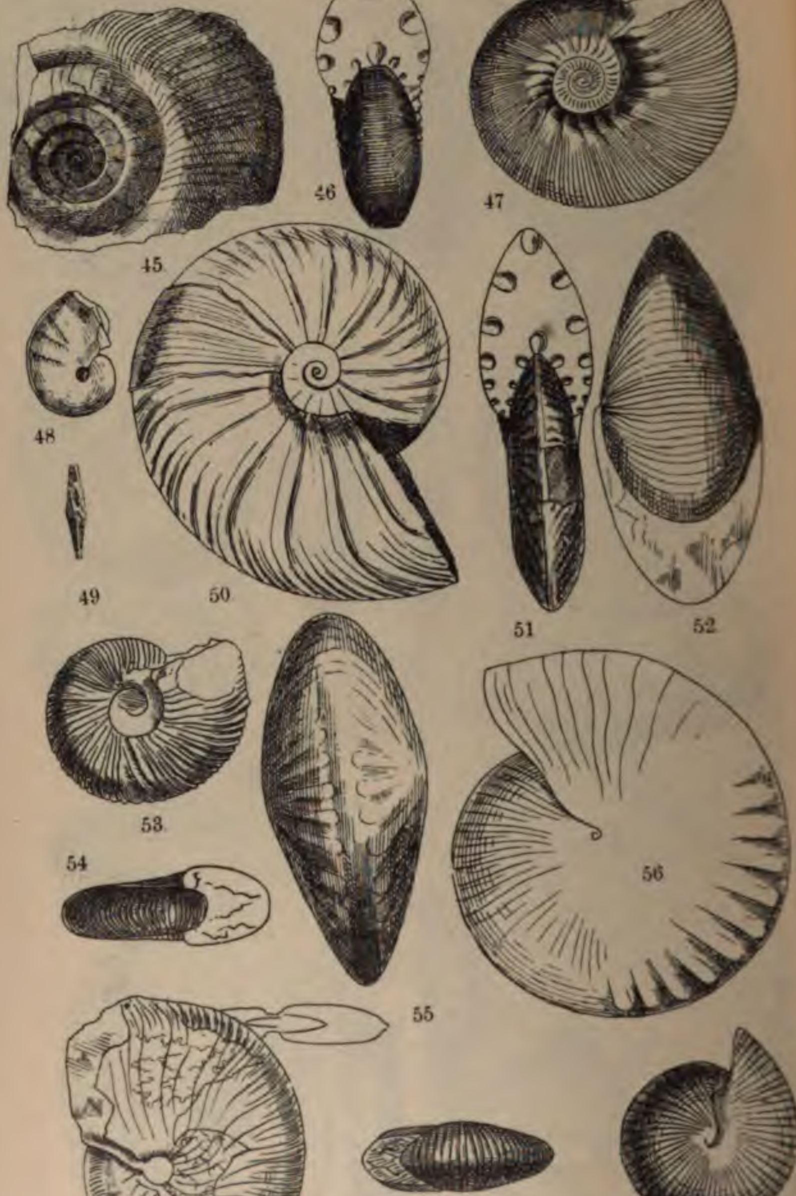


PLATE 39.

PLATE 40.



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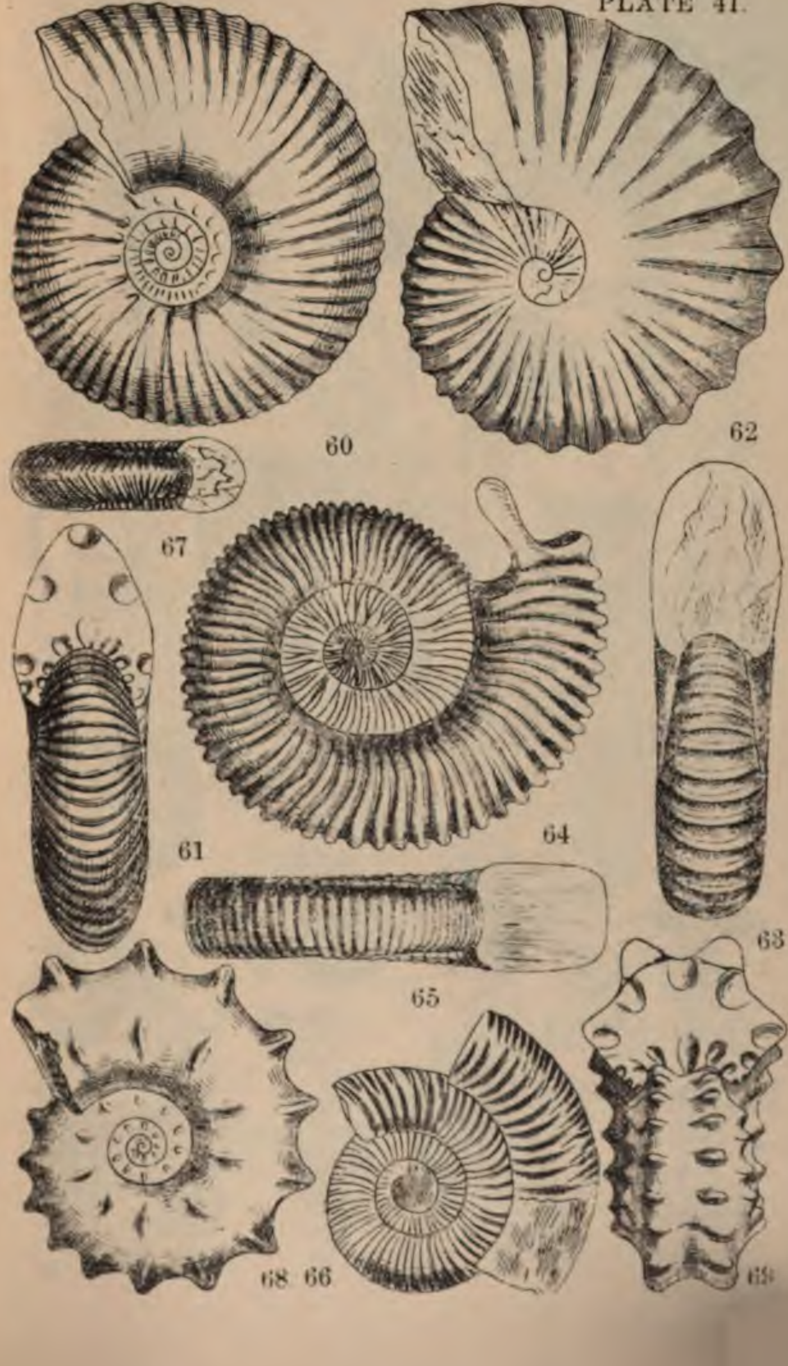

PLATE 42.

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PLATE 43.

PLATE 44.

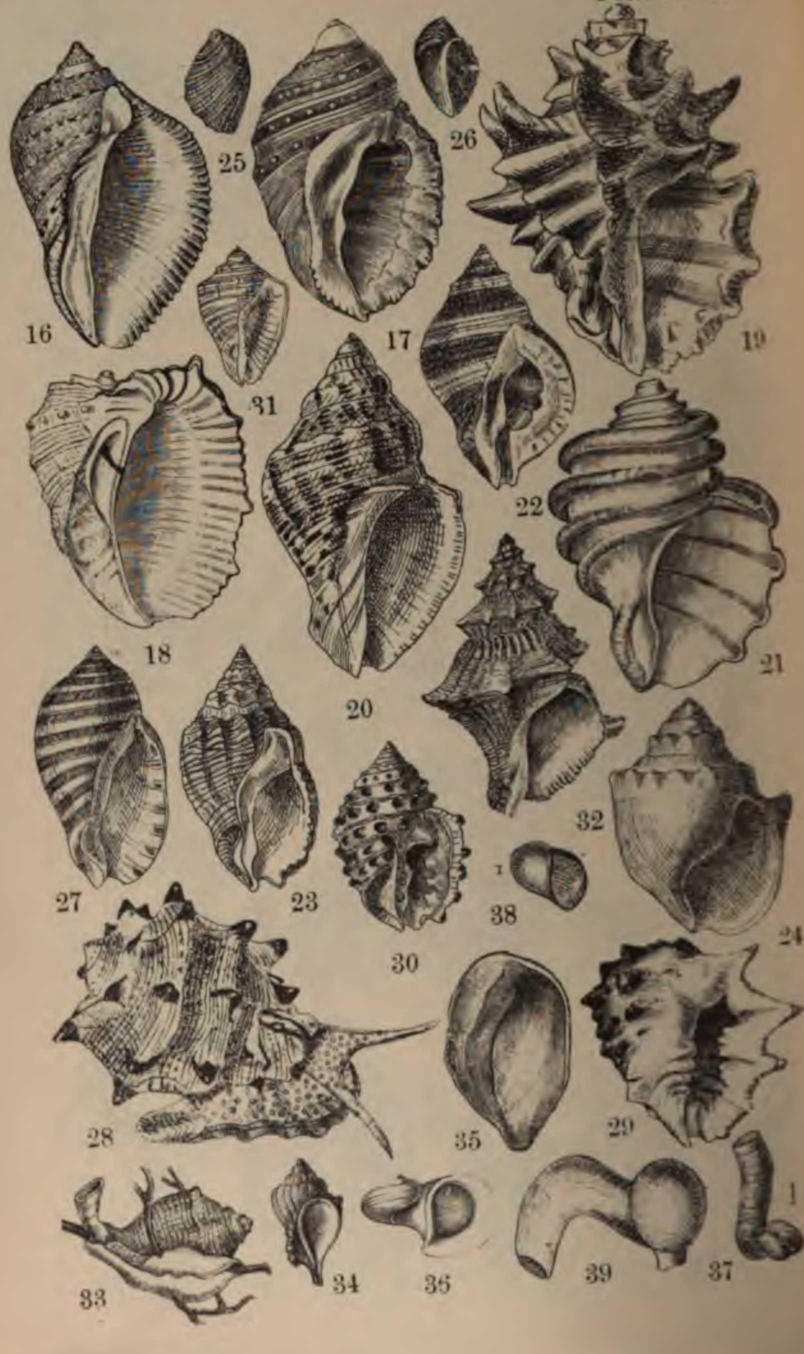

PLATE 45.

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PLATE 47.

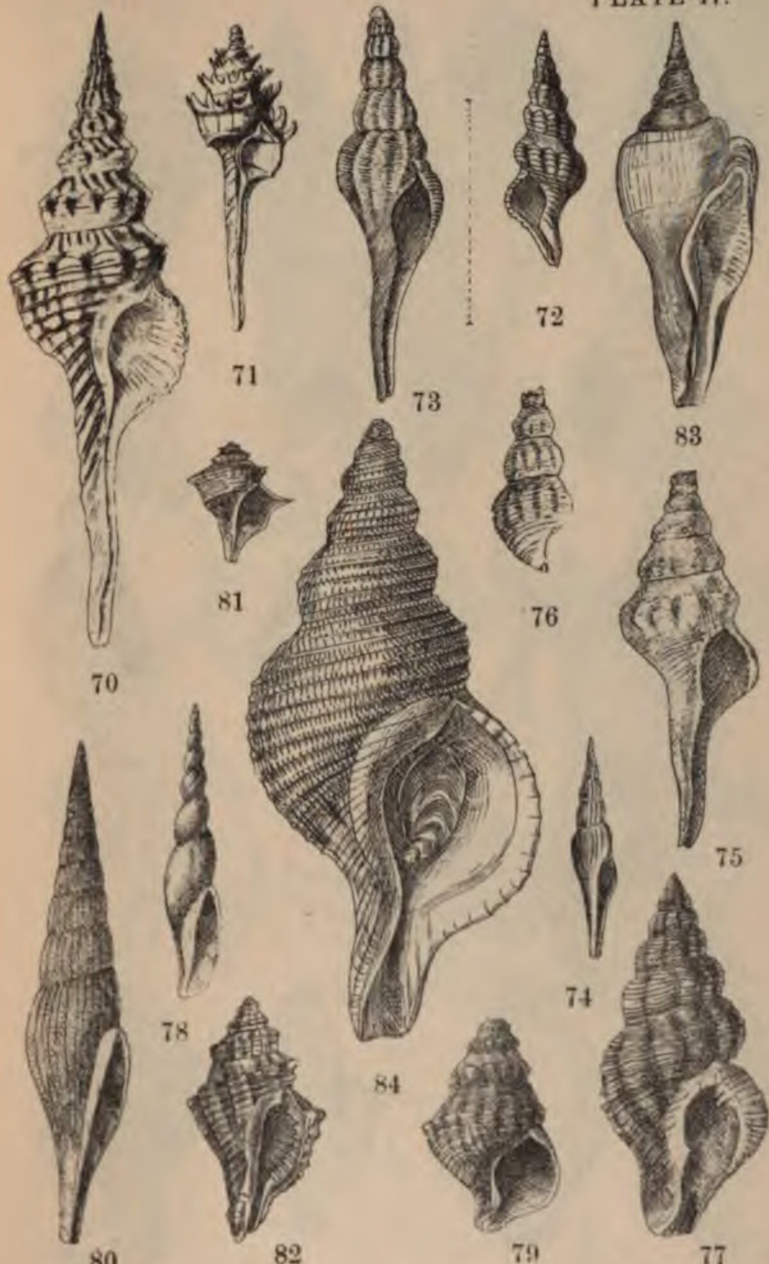


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PLATE 51.


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PLATE 52.

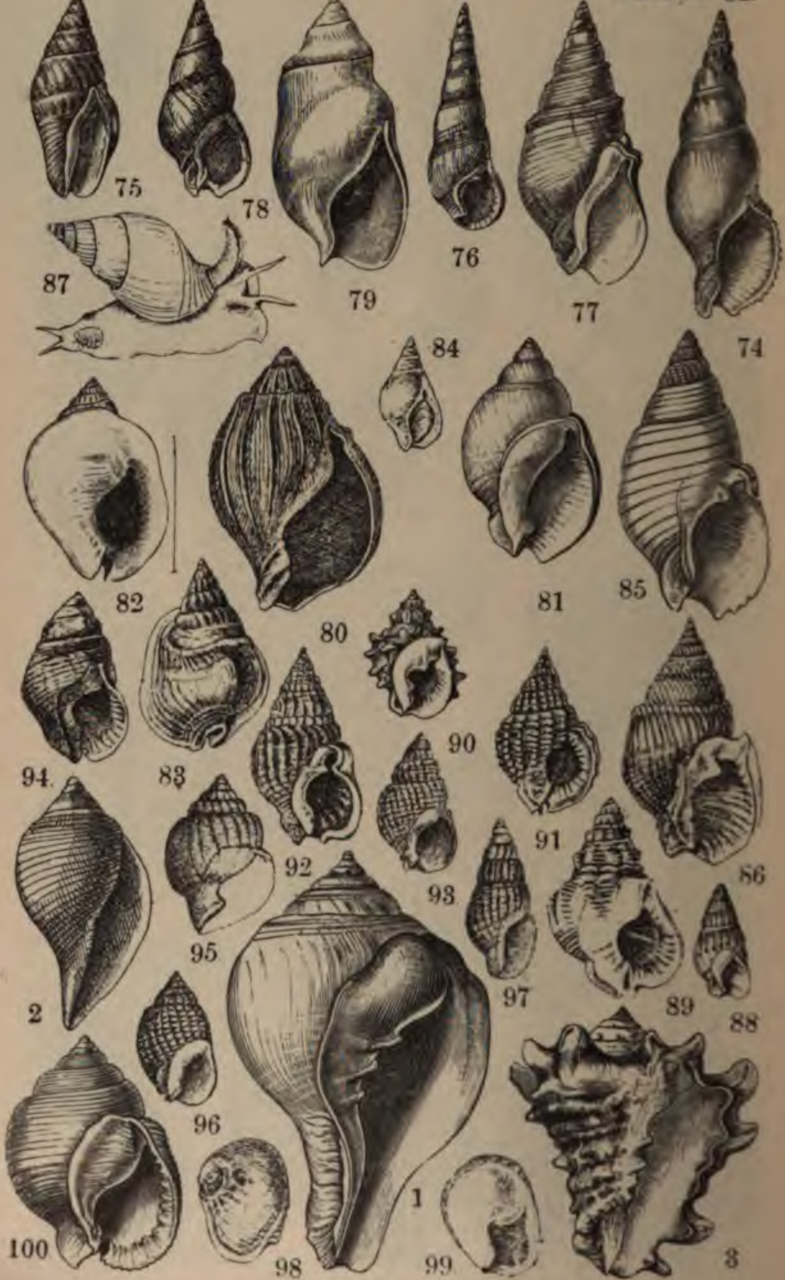
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PLATE.53.

PLATE 54

PLATE 55.


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PLATE 56

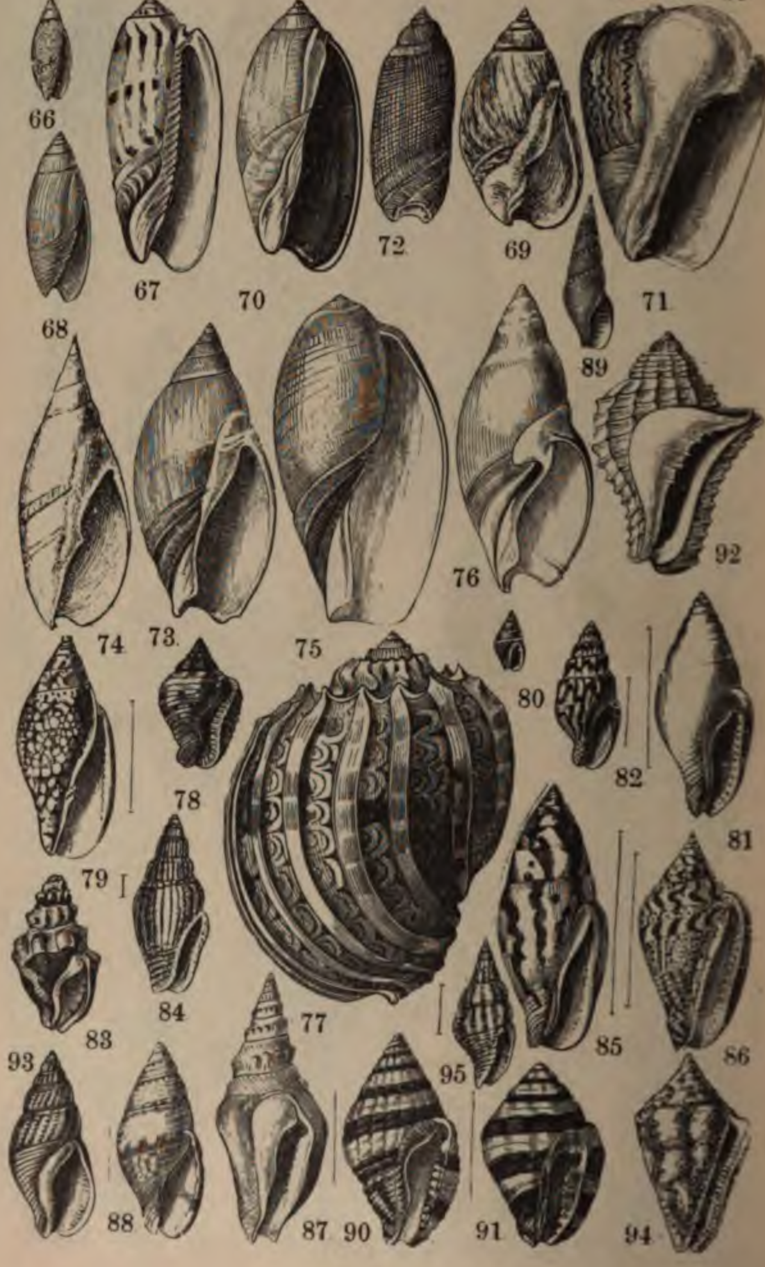
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PLATE 57.

PLATE 58.

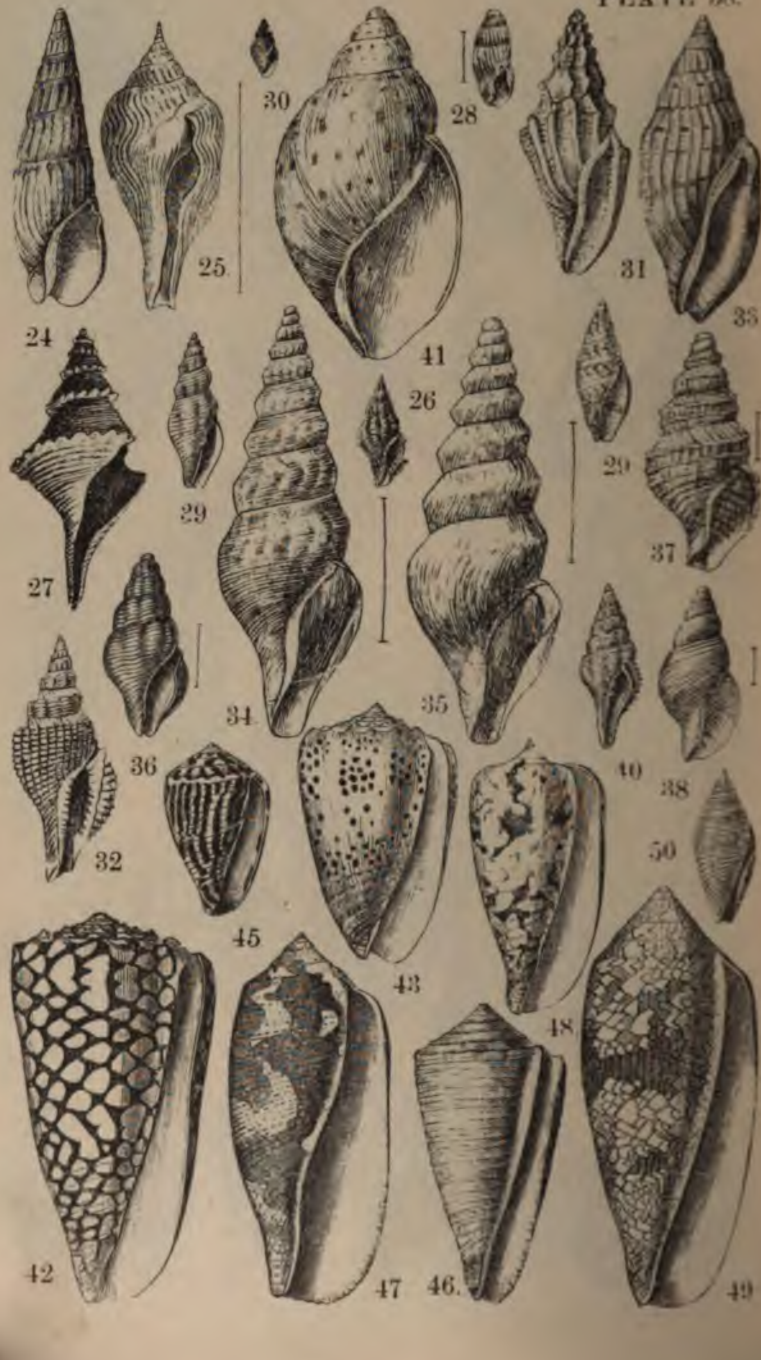

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PLATE 59.

PLATE 60.


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PLATE 62.

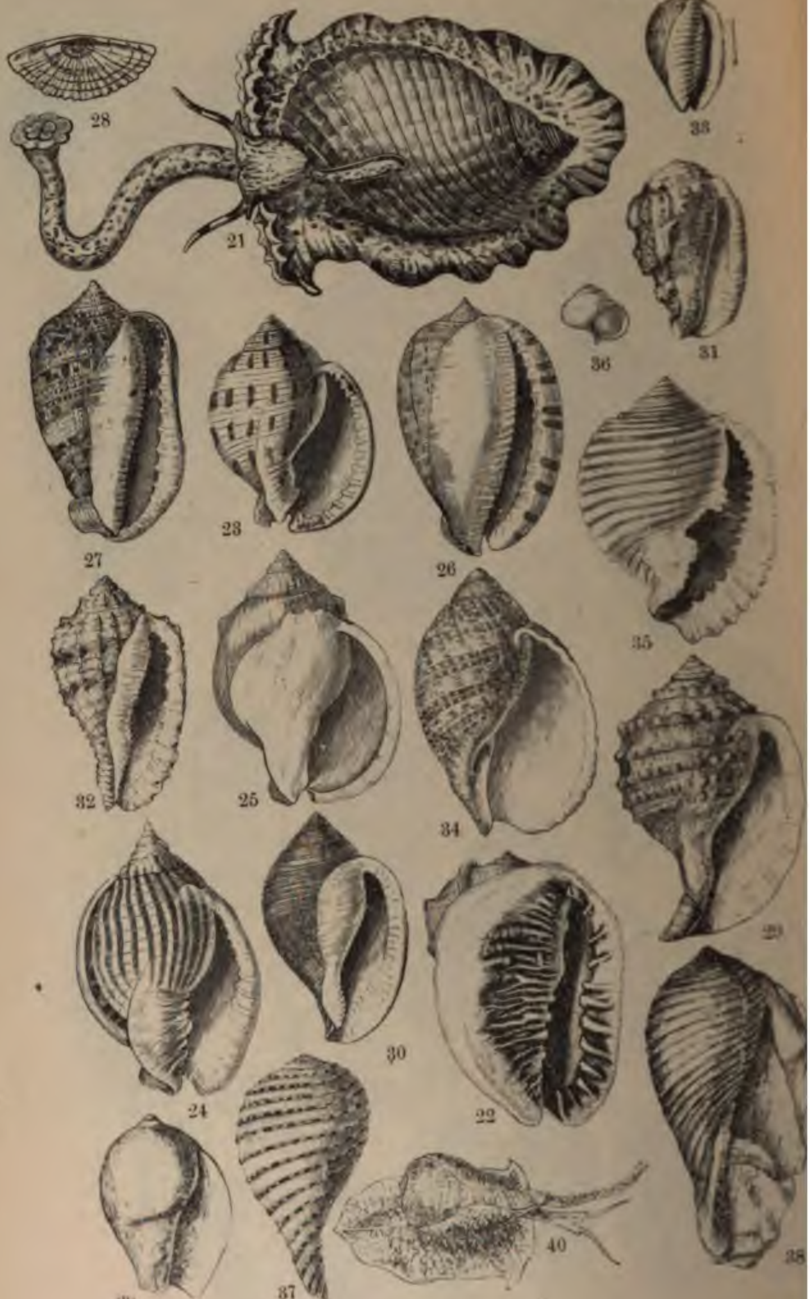

PLATE. 63.

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PLATE 64

PLATE 65


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PLATE 66

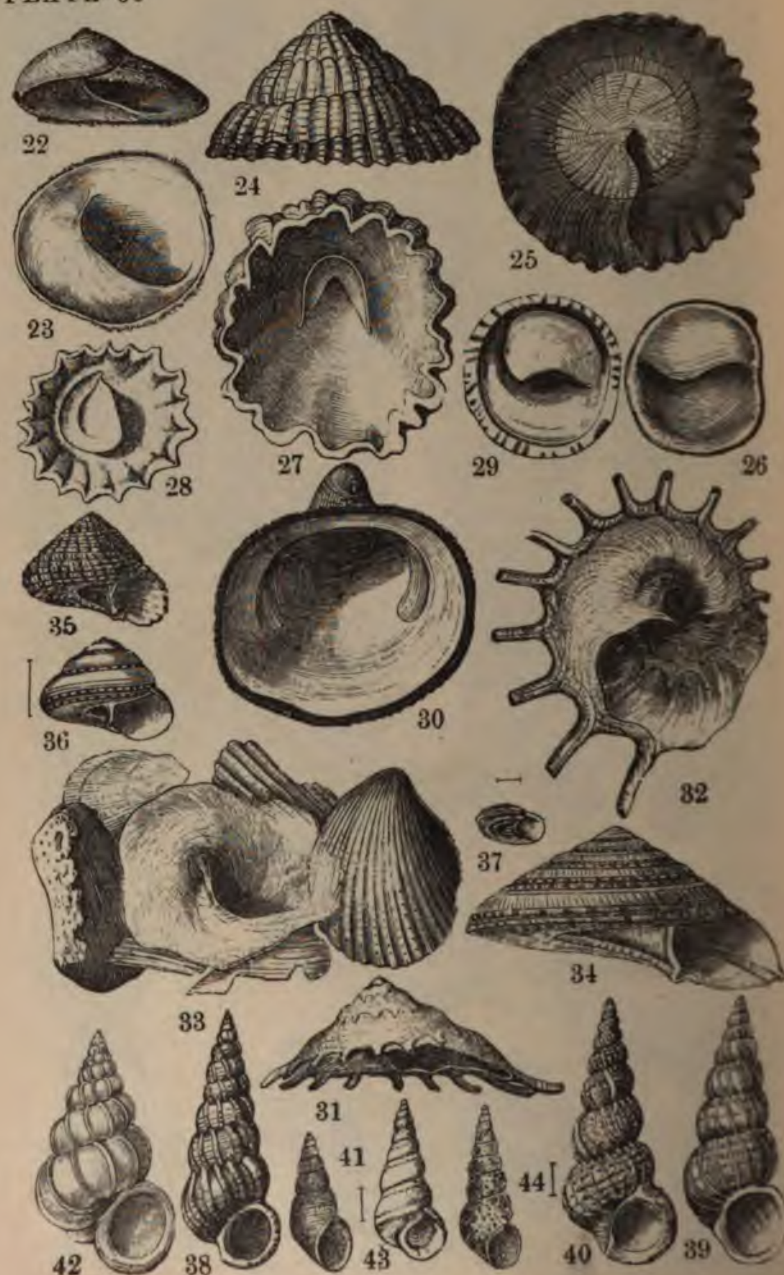

PLATE 67


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PLATE 68


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PLATE 70.


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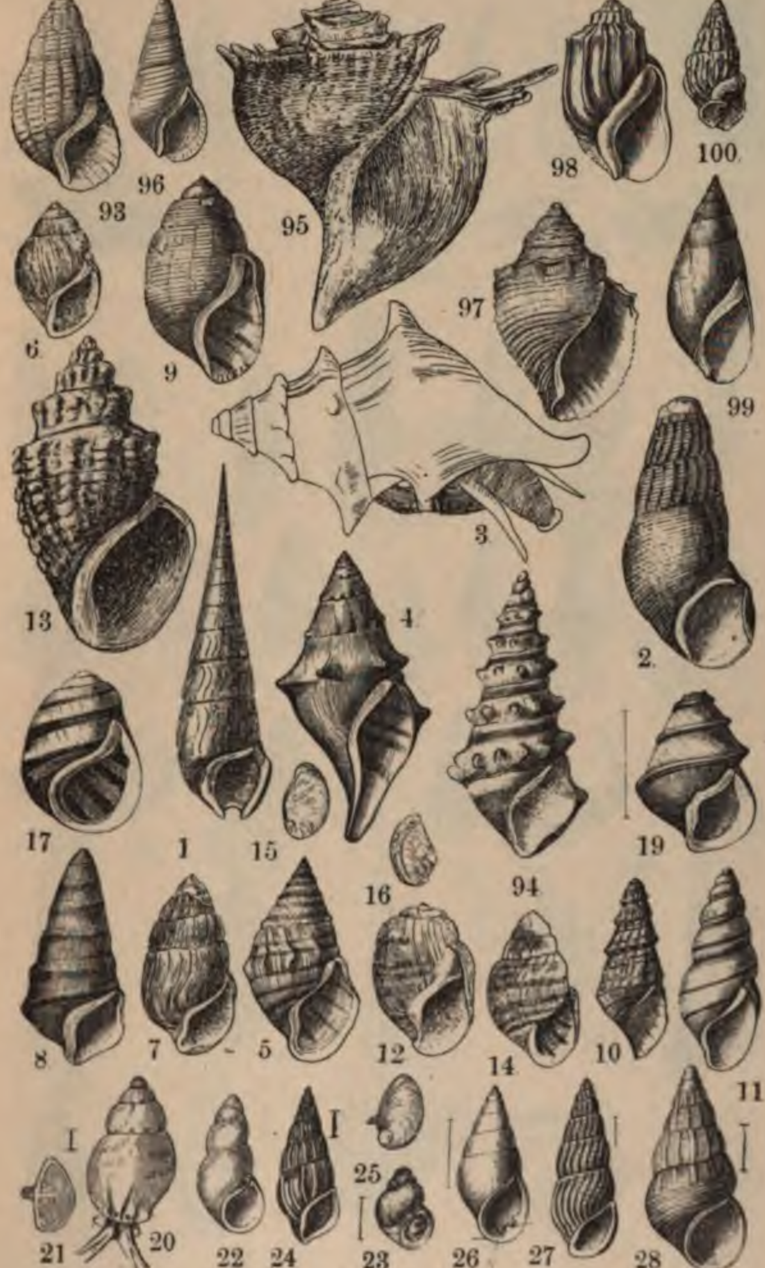
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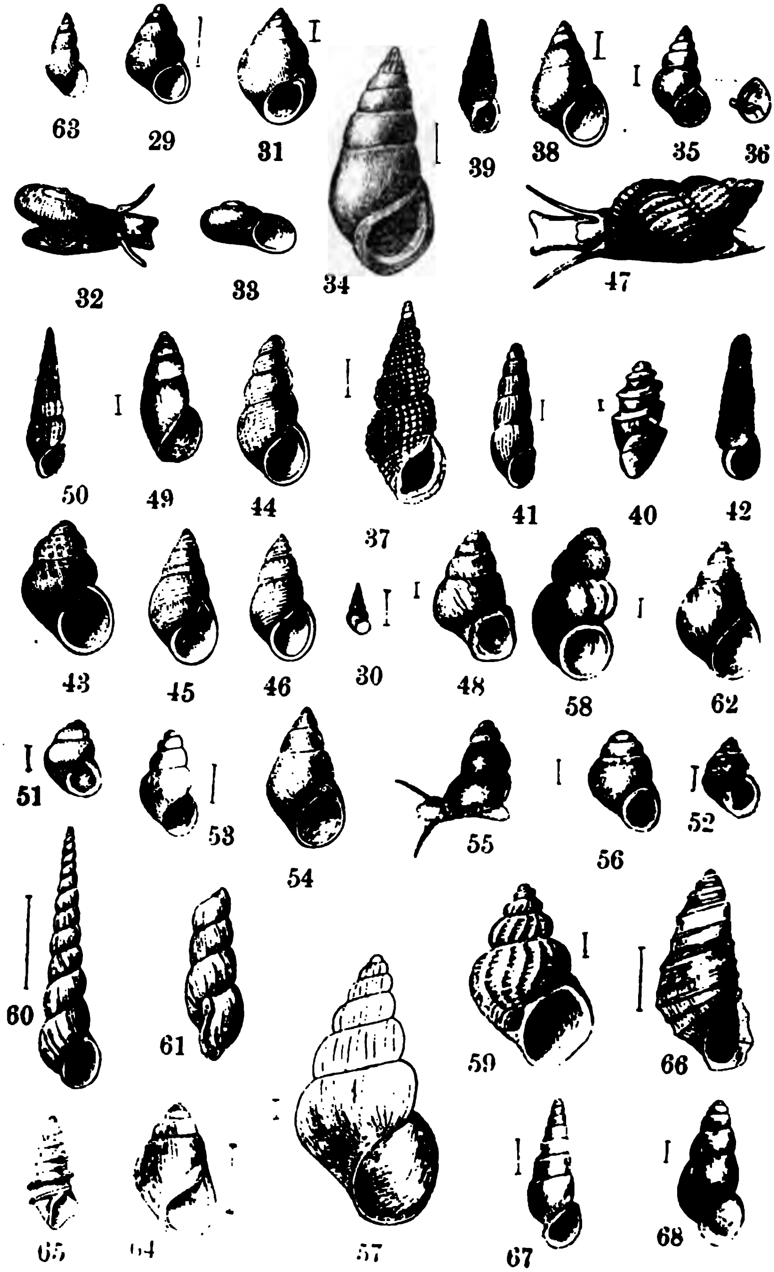
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PLATE 74

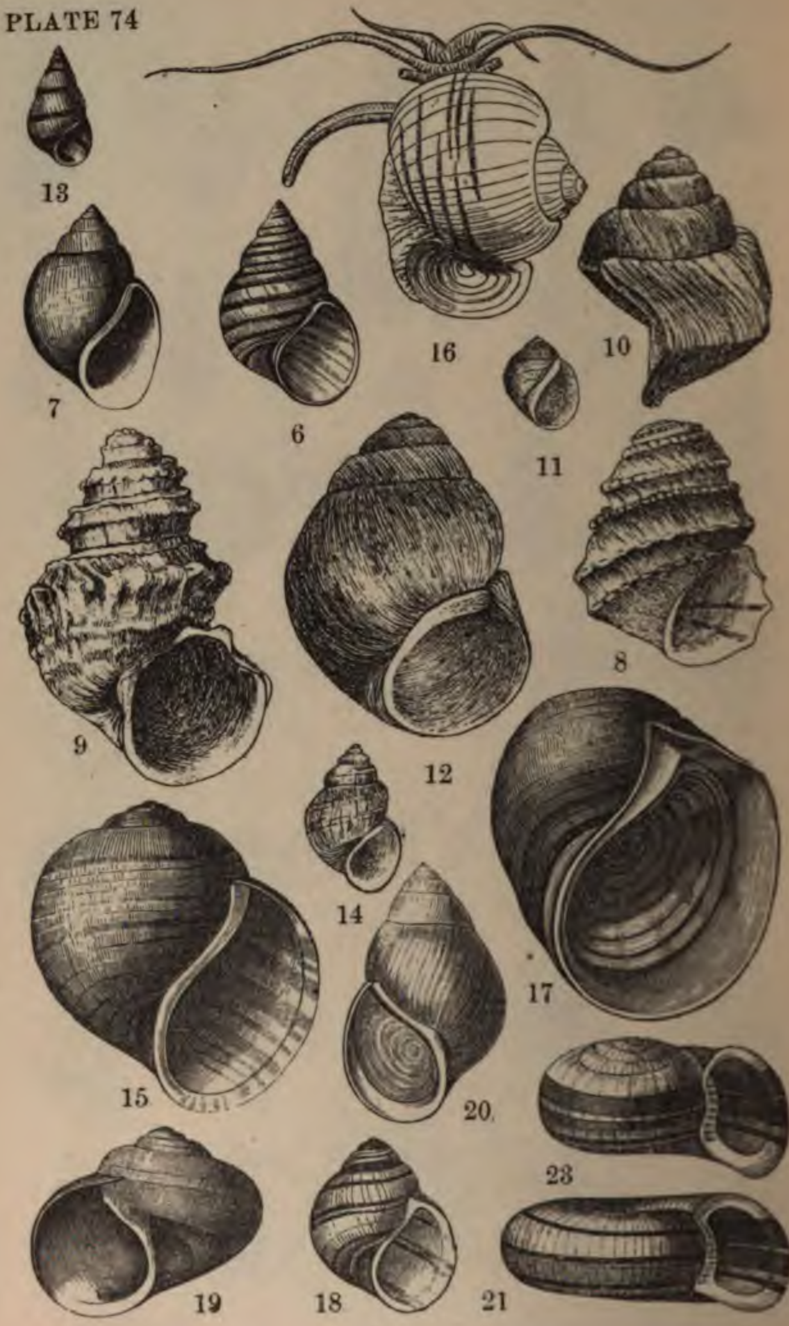

PLATE 75

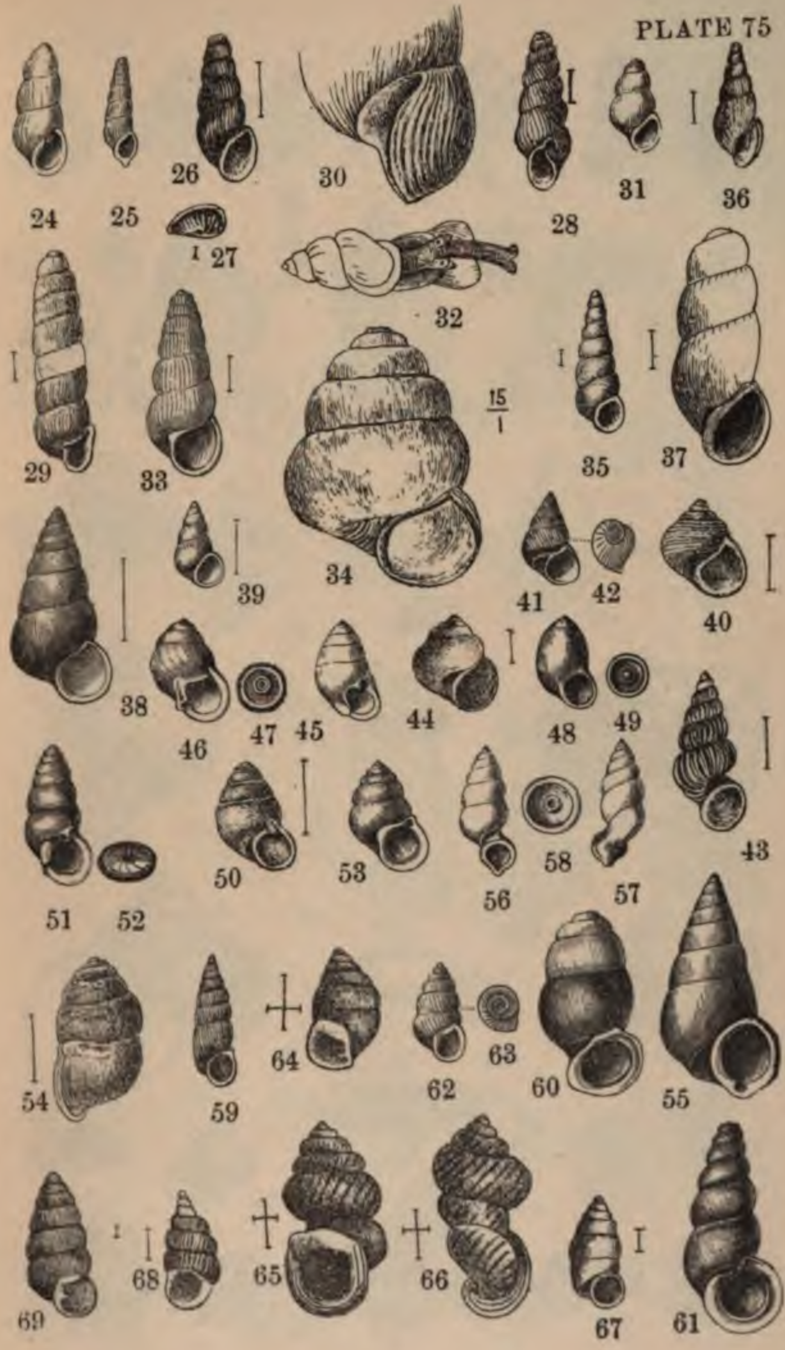

PLATE 76

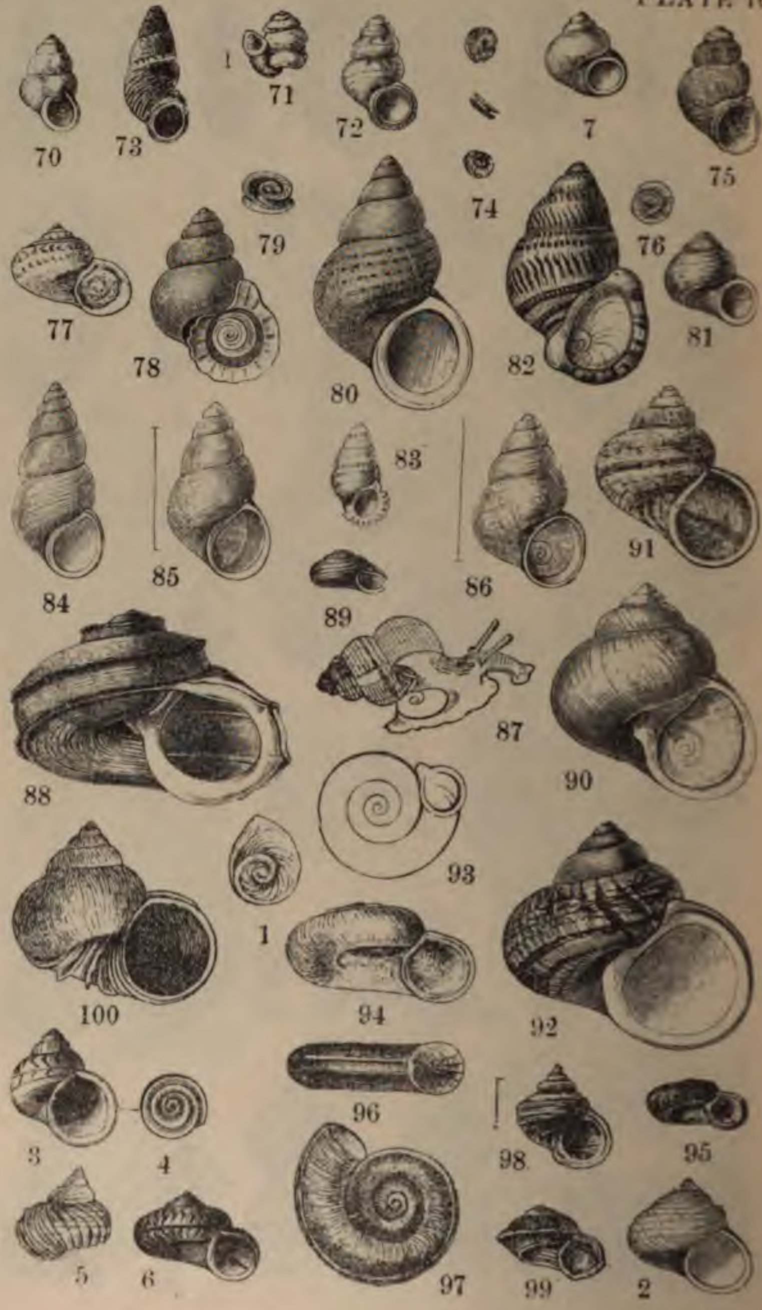

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PLATE 77


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PLATE 78.


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PLATE 79.


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PLATE 80.

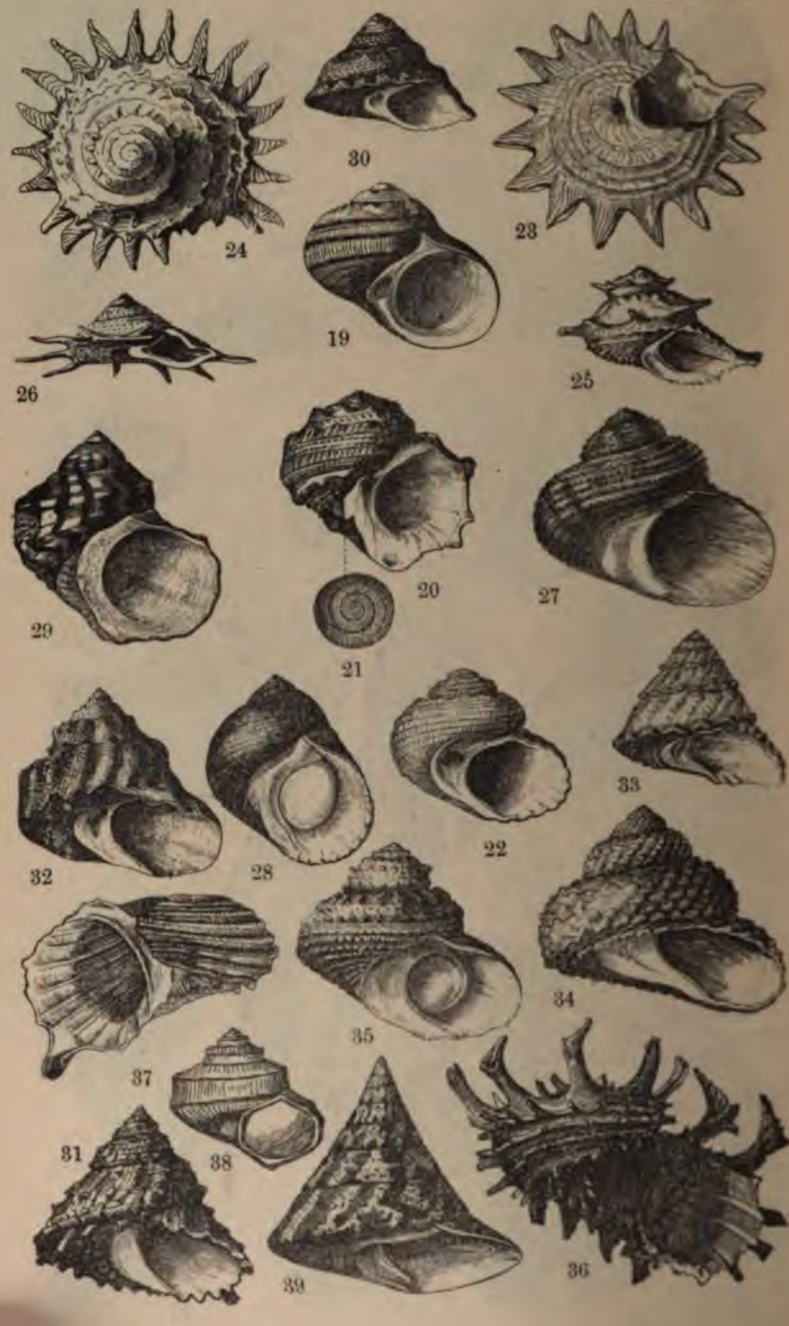

PLATE 81.

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PLATE 82.


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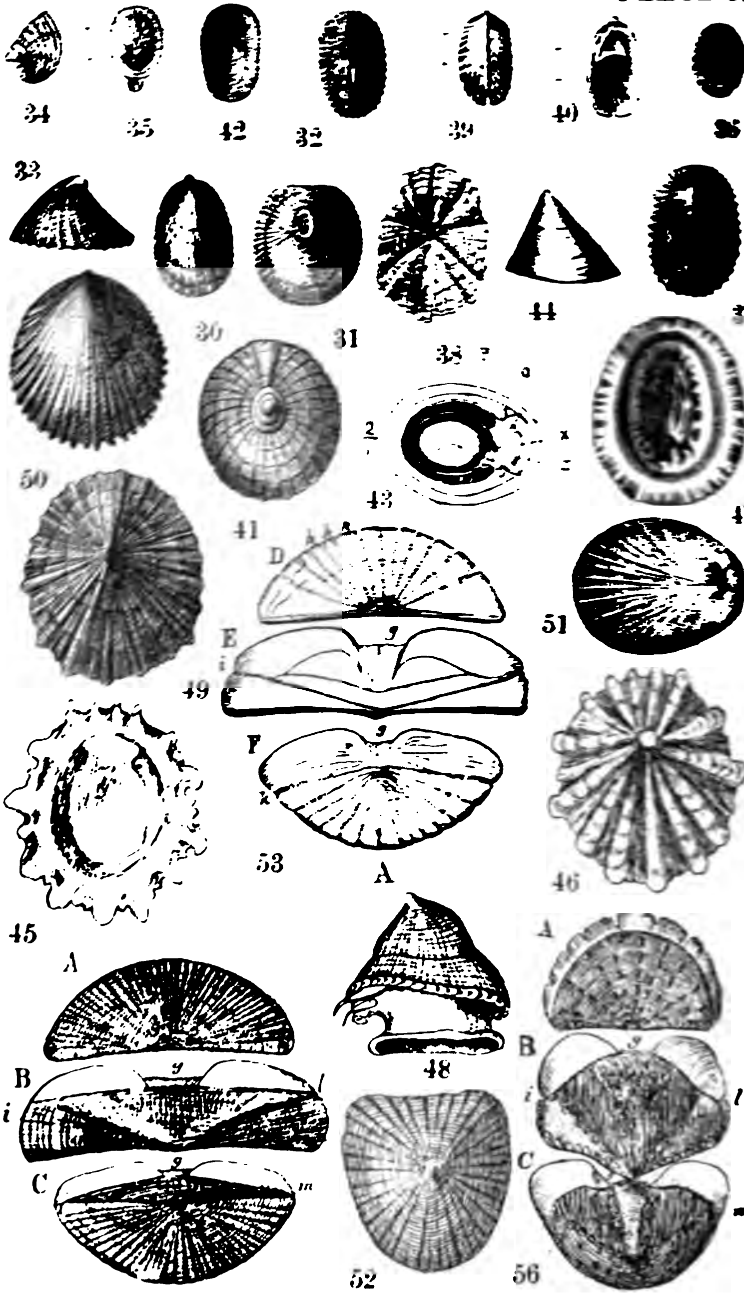
PLATE 34.



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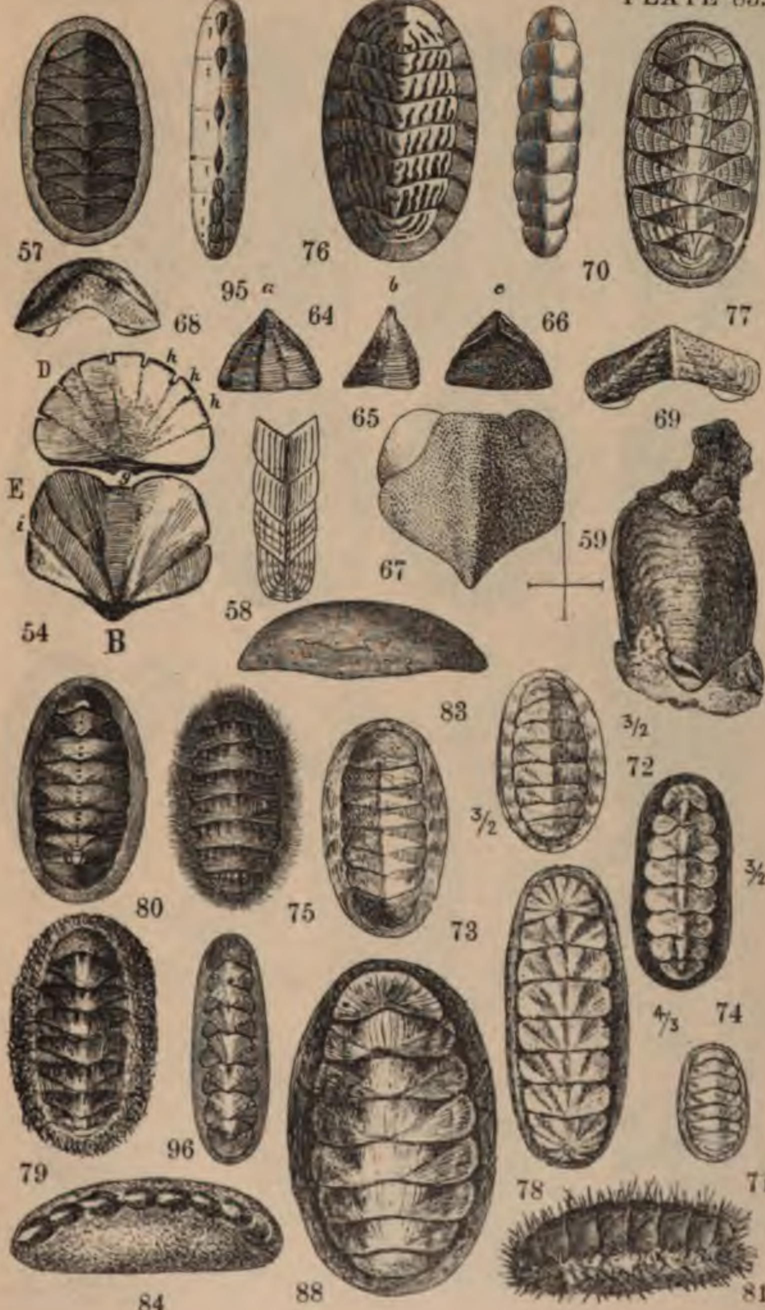
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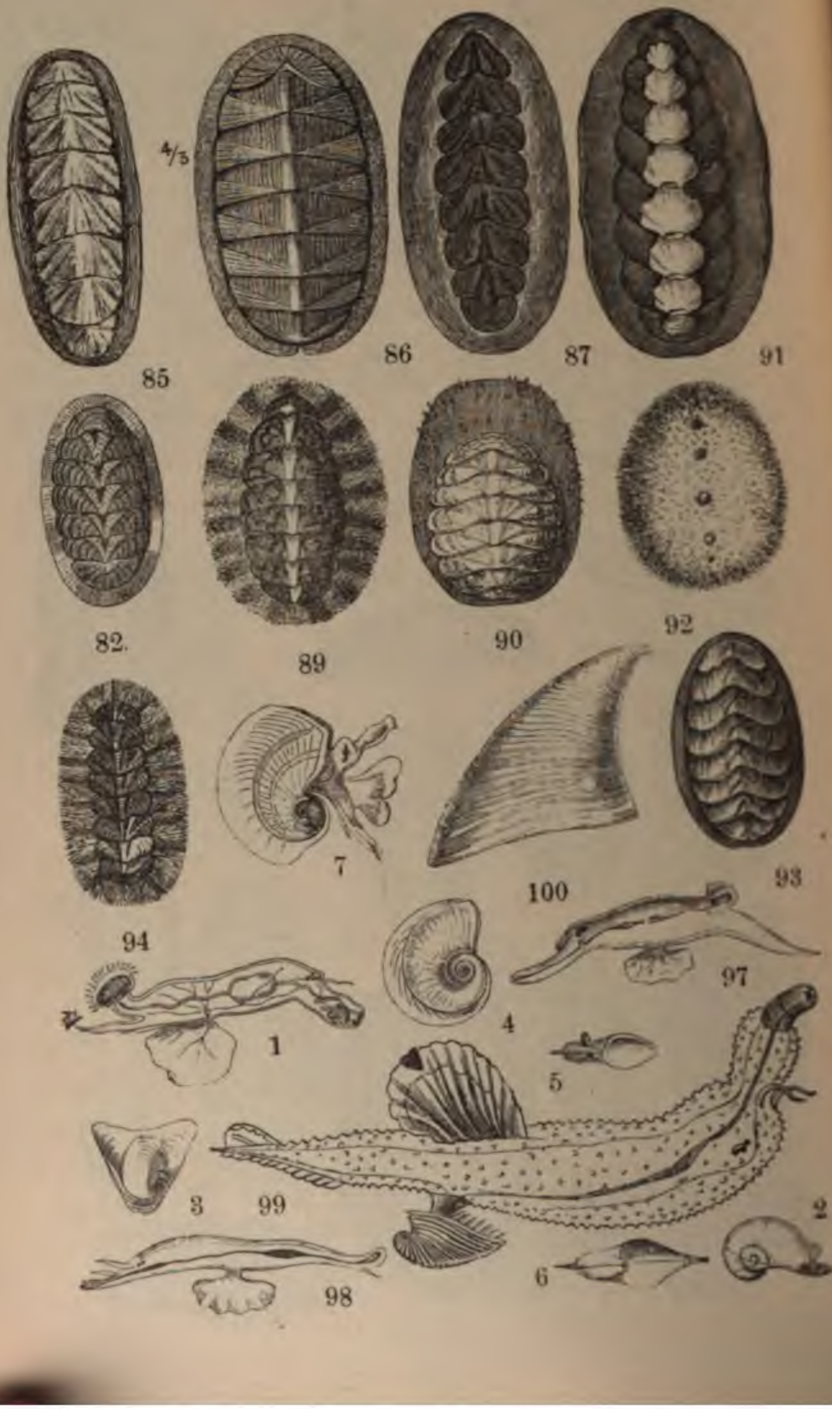
PLATE 86.



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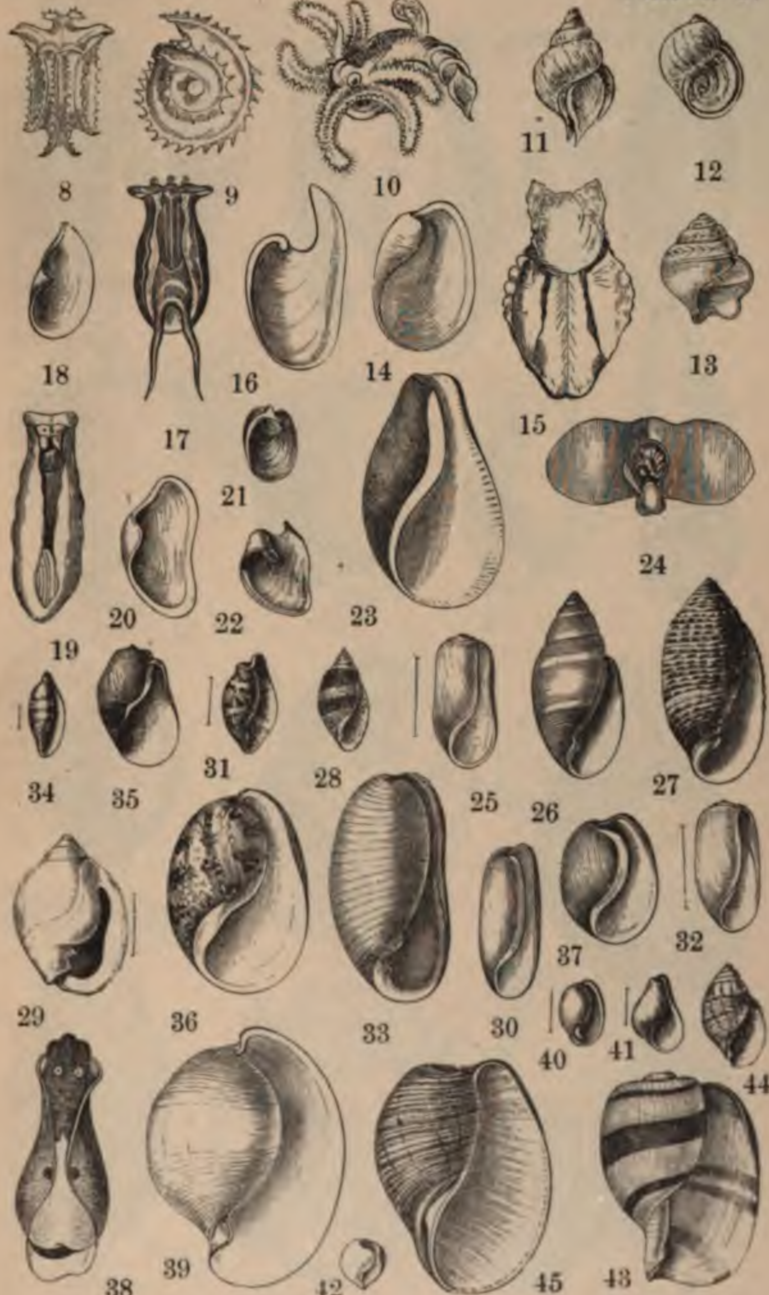
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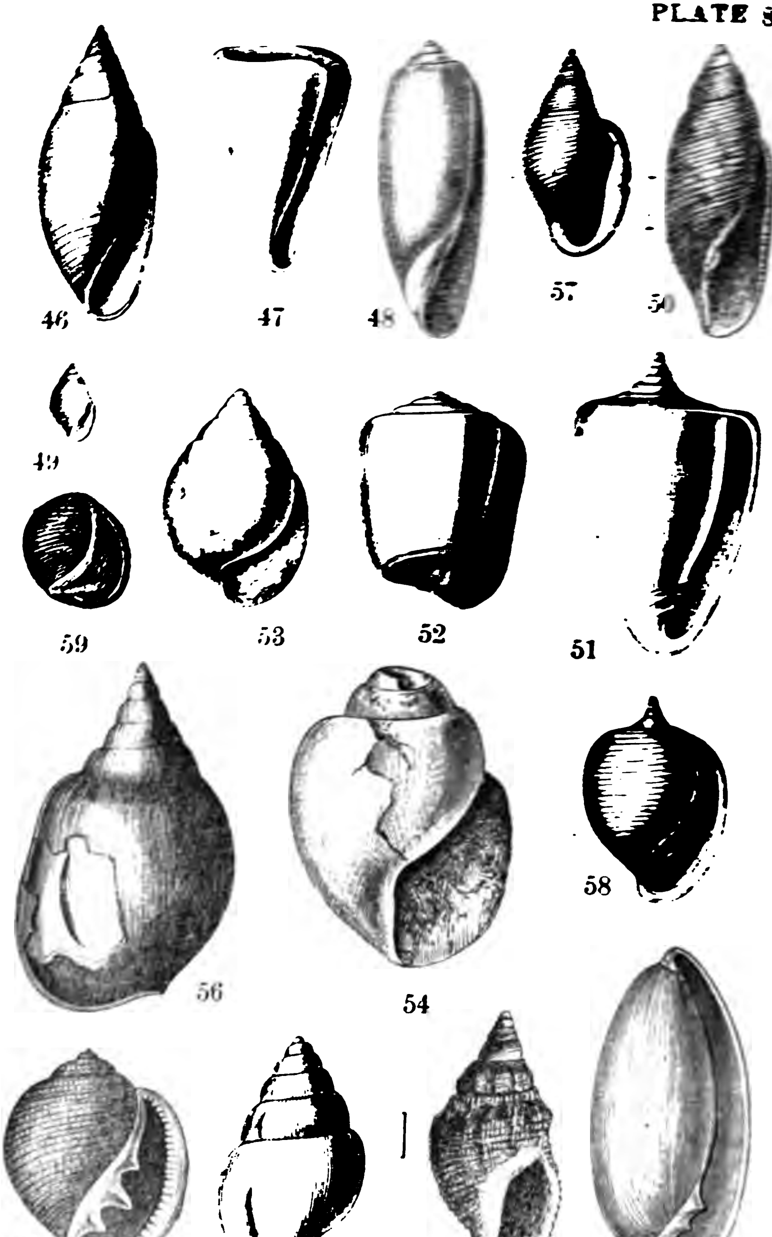
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PLATE 90

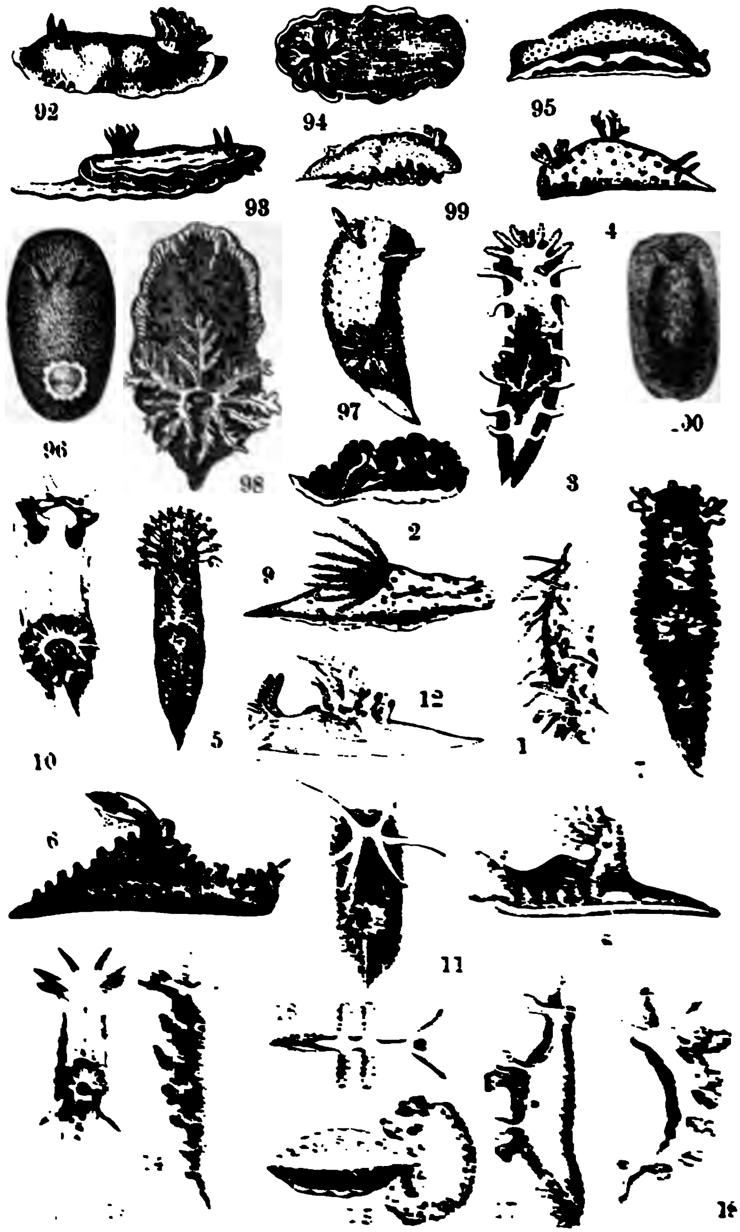

PLATE 91

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PLATE 92


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PLATE 93

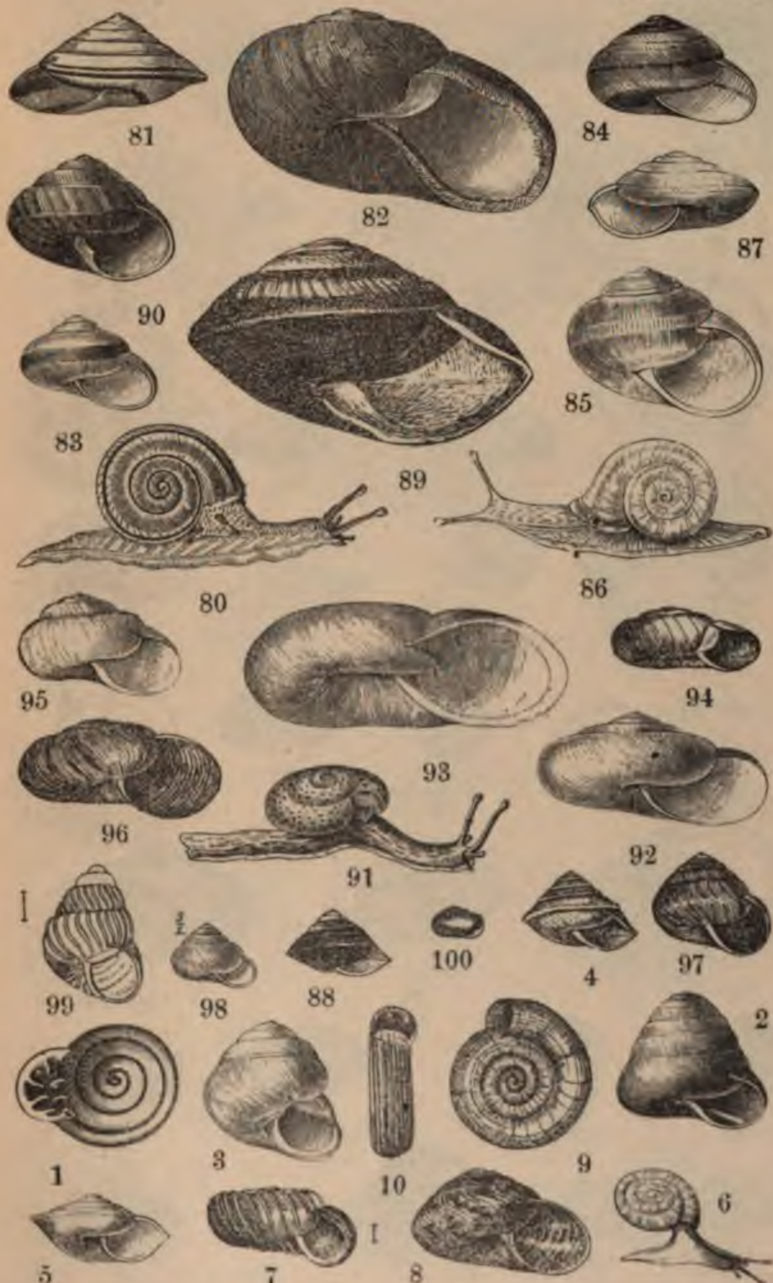
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PLATE 94


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PLATE 95


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PLATE 96

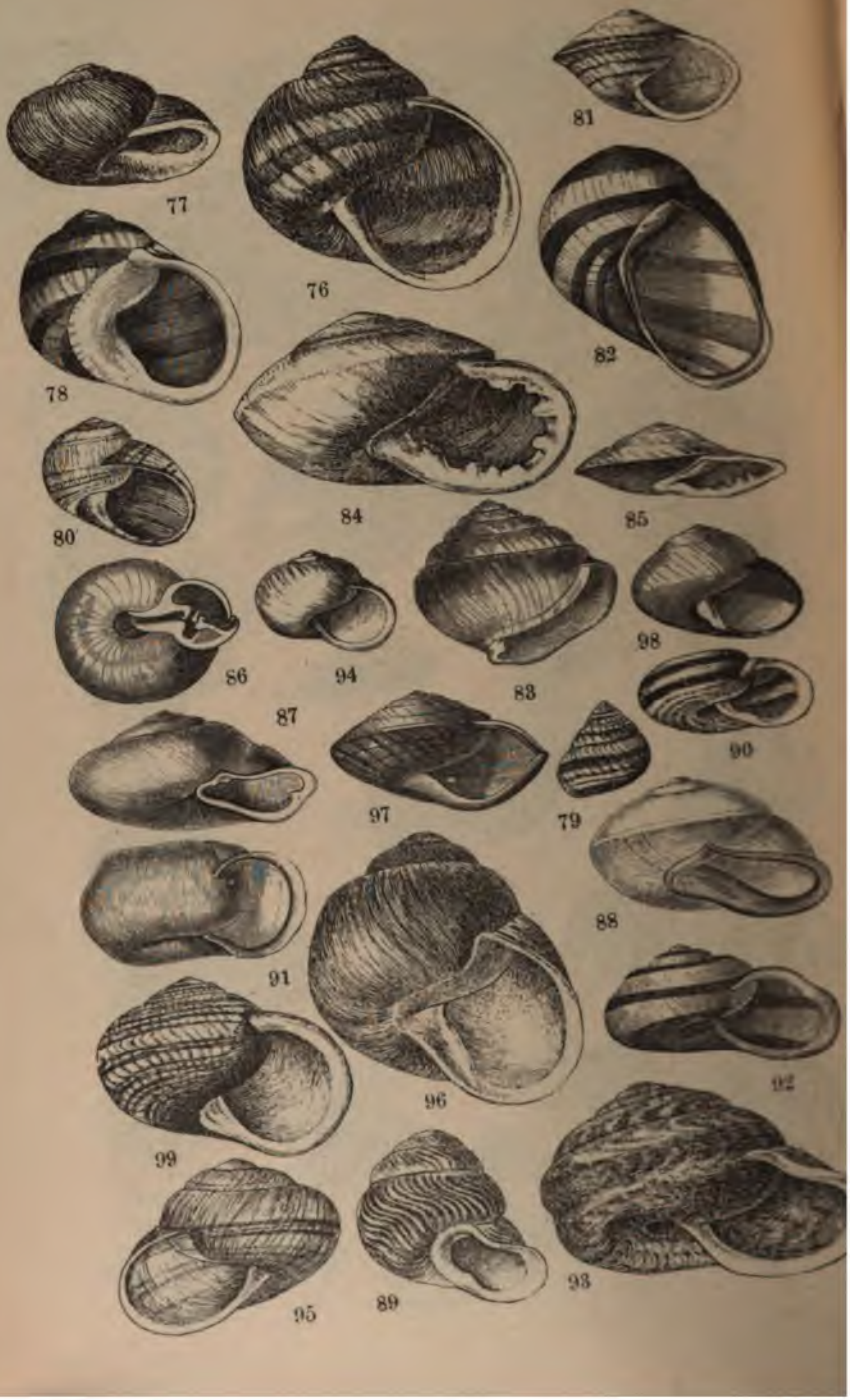


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PLATE 98

PLATE 99.


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PLATE 101.

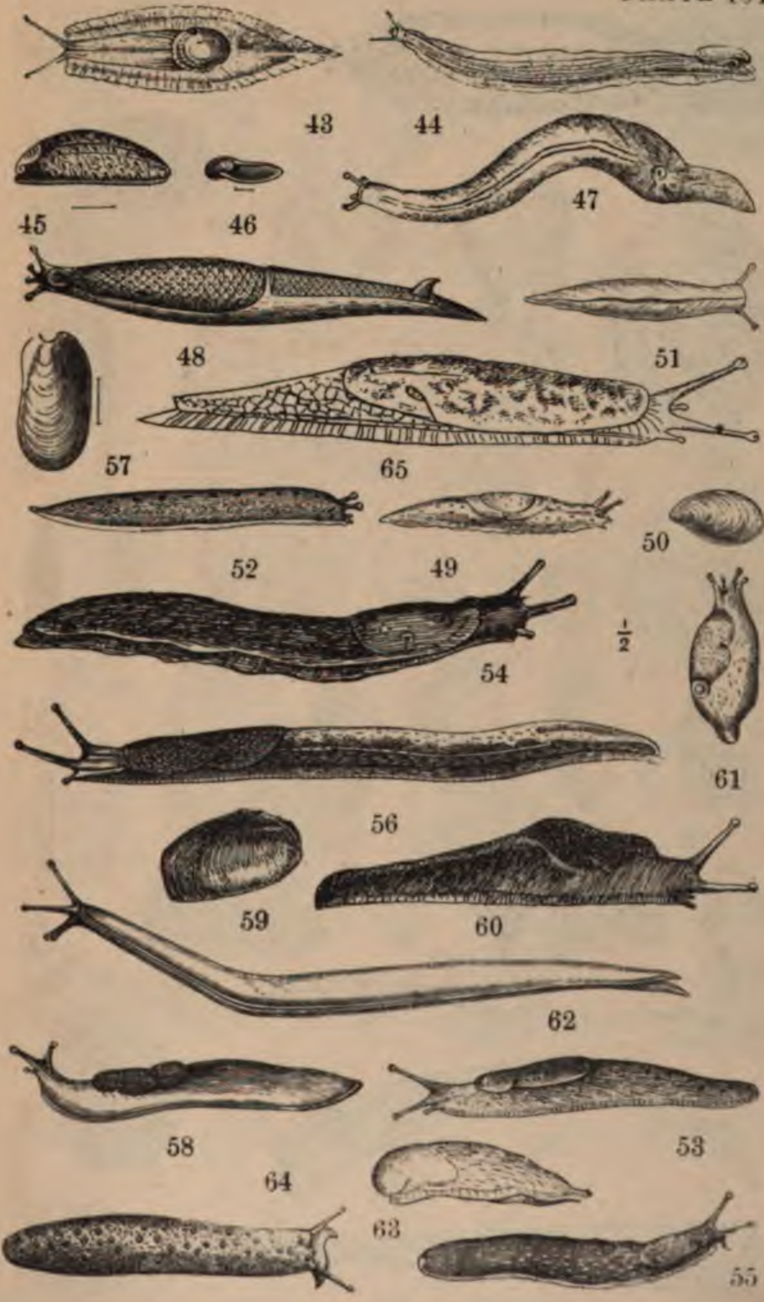

PLATE 102.

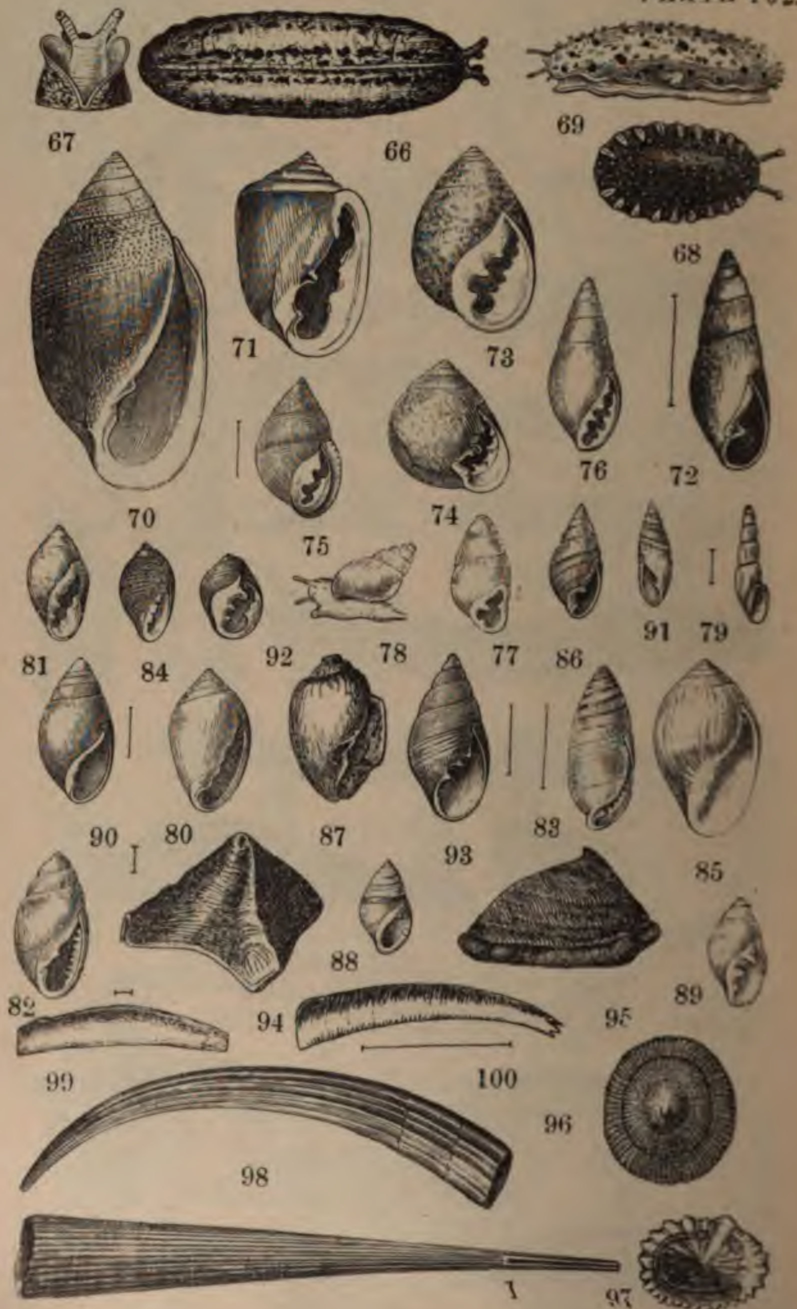

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PLATE 103.

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PLATE 104


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PLATE 106

PLATE 107

PLATE 108


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PLATE 109


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PLATE 110


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PLATE III


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PLATE 113


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PLATE 115

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PLATE 116

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PLATE 117


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PLATE 119


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PLATE 120

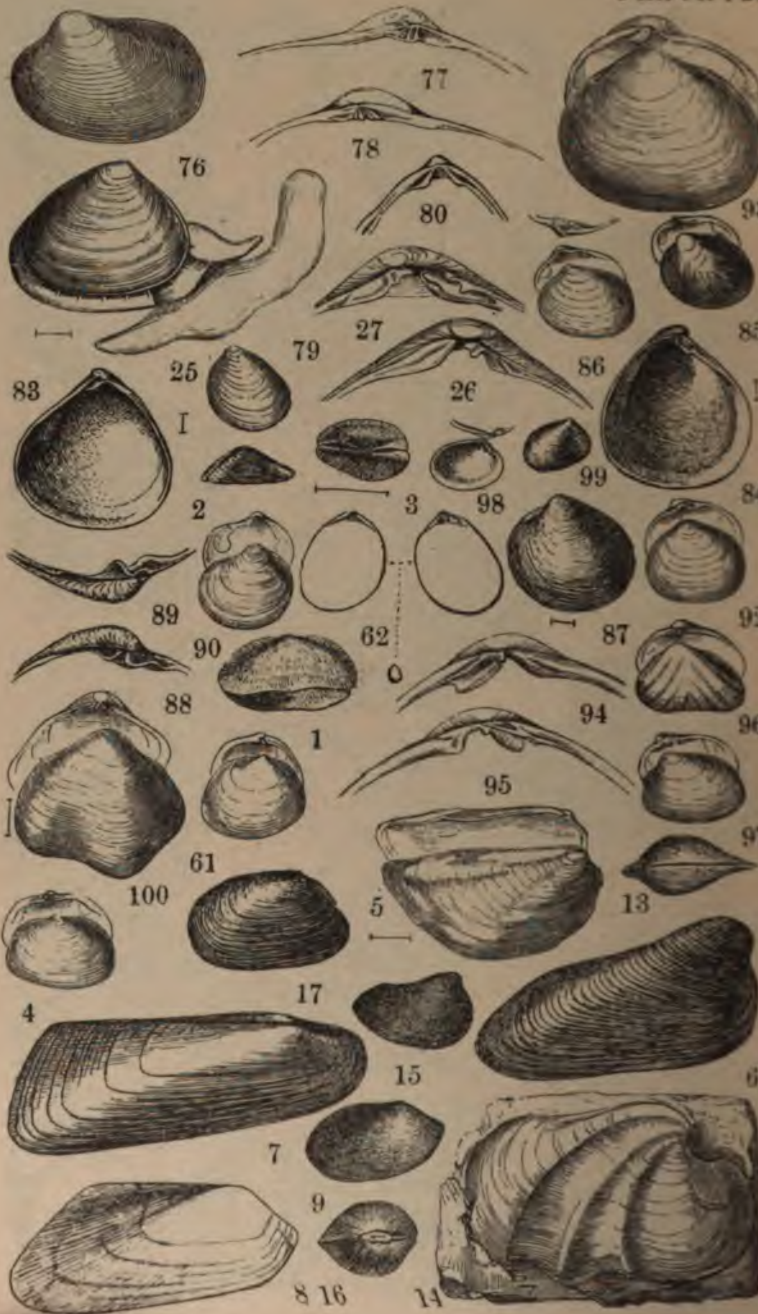
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PLATE 121

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PLATE 123


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PLATE 124

PLATE 125

PLATE 126

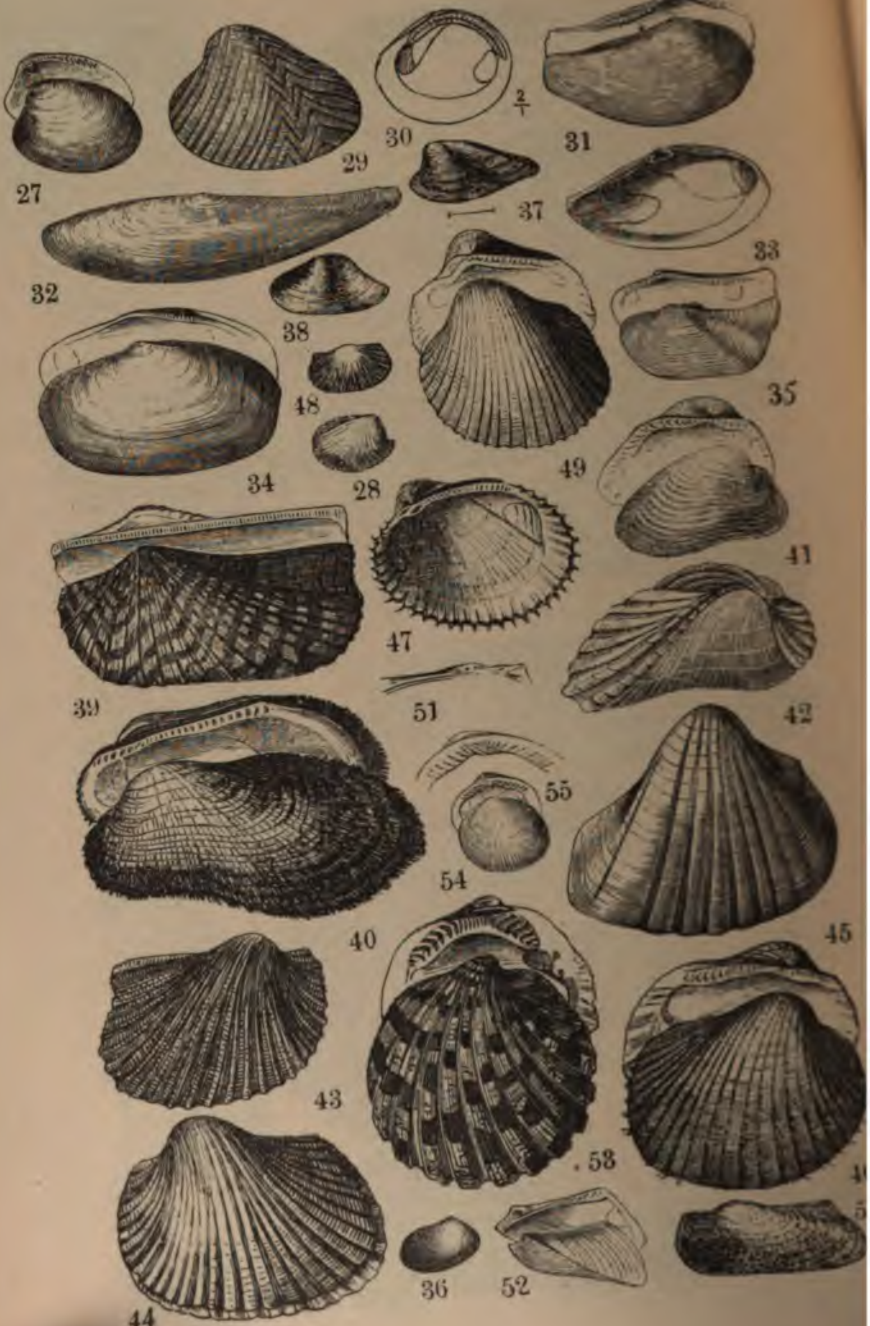
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PLATE 128


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PLATE 130


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PLATE 131

PLATE 132


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PLATE 133

PLATE 134

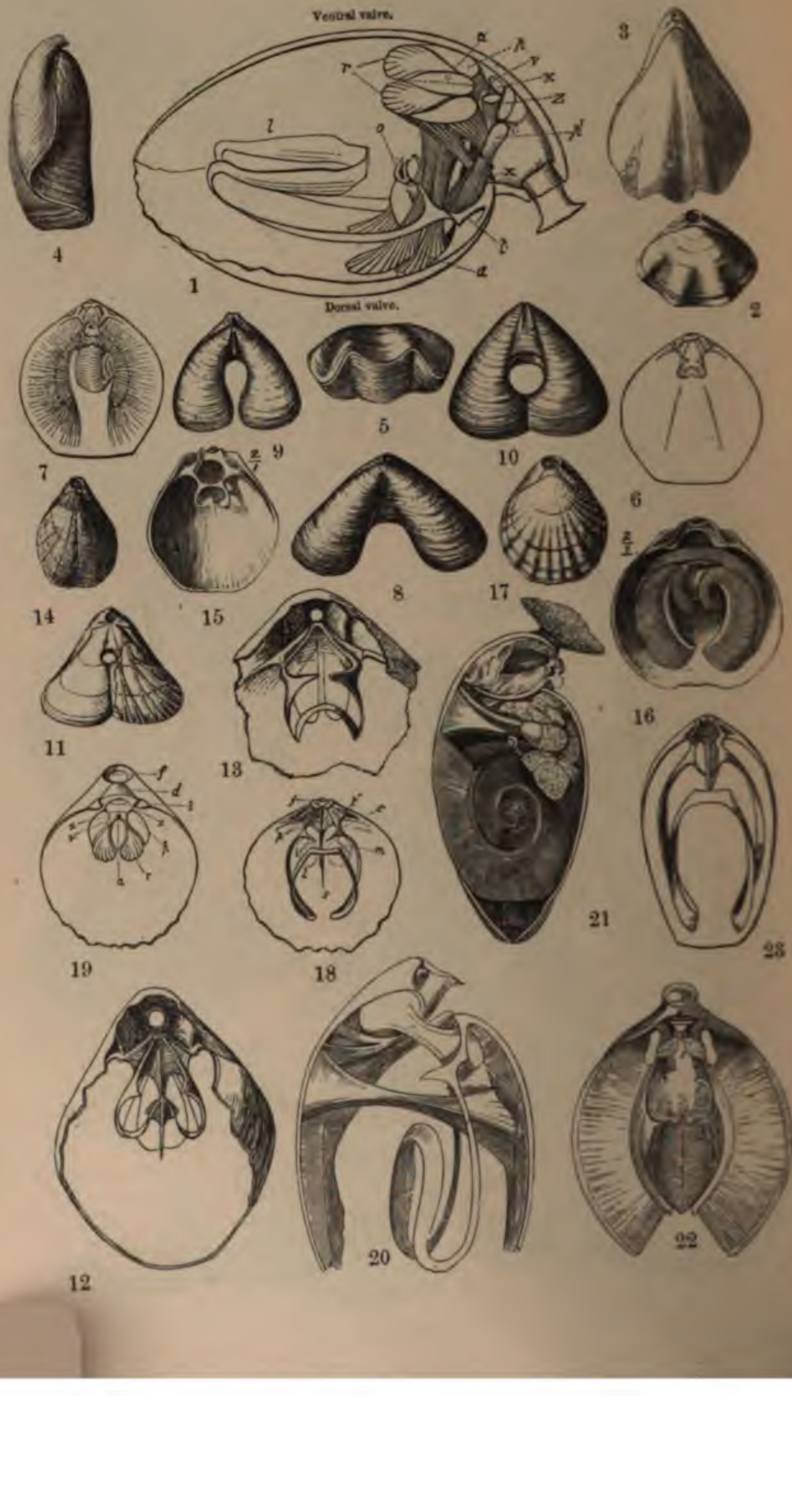
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PLATE 135

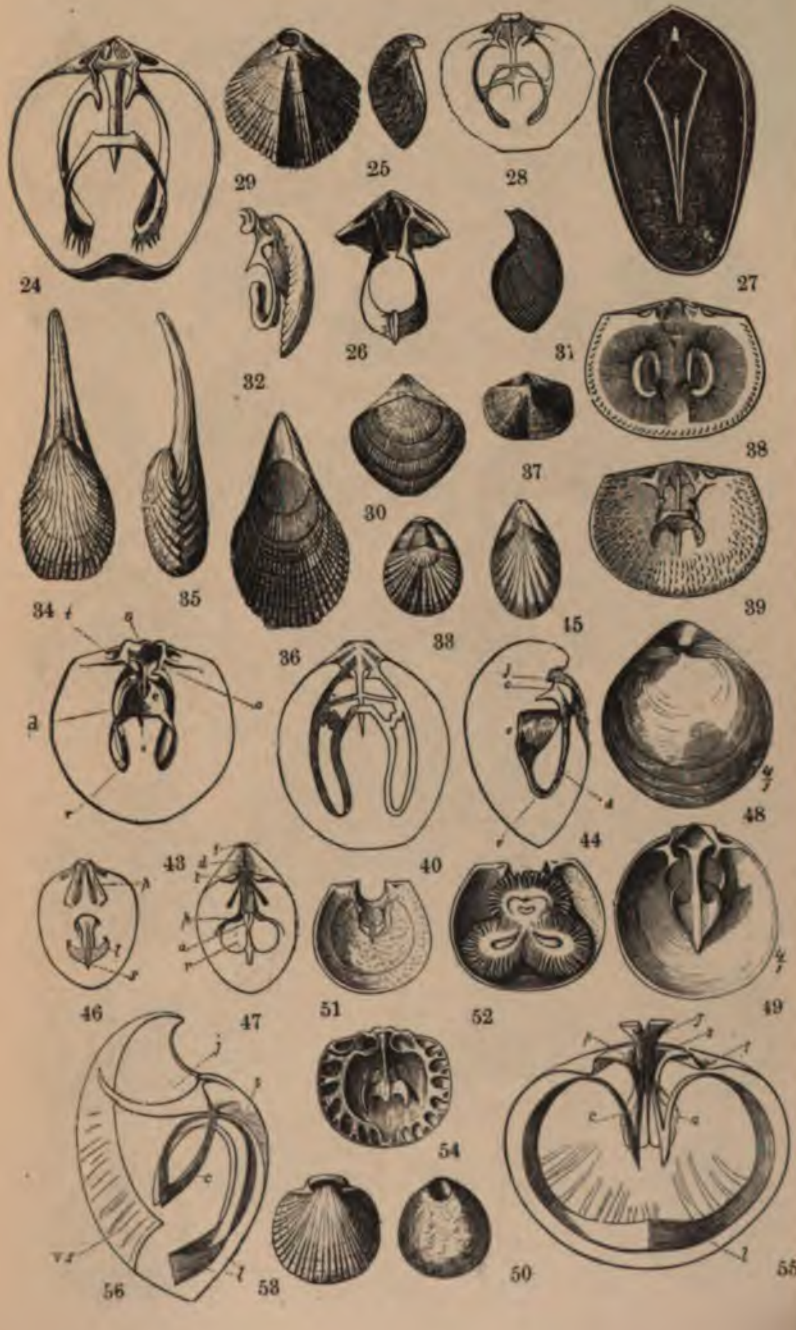
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PLATE 136

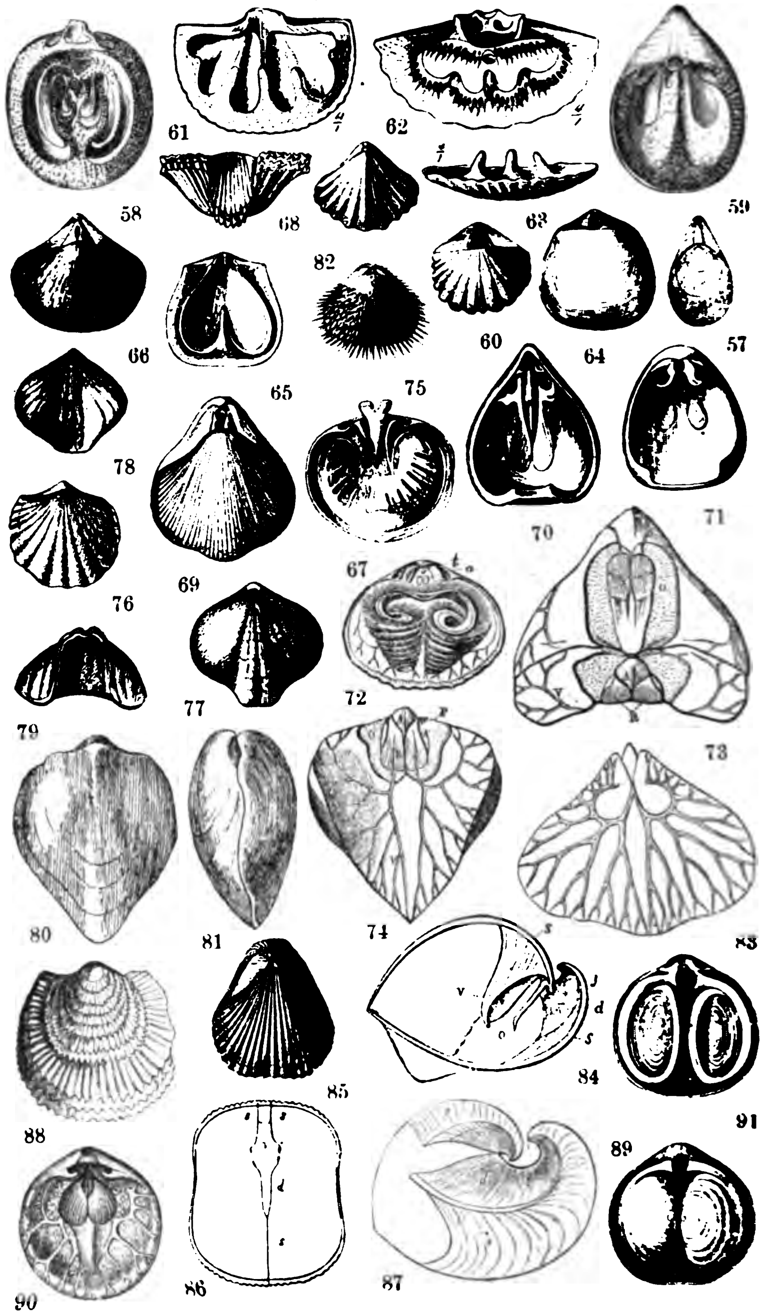
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PLATE 137

PLATE 138

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PLATE 140